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Plastics

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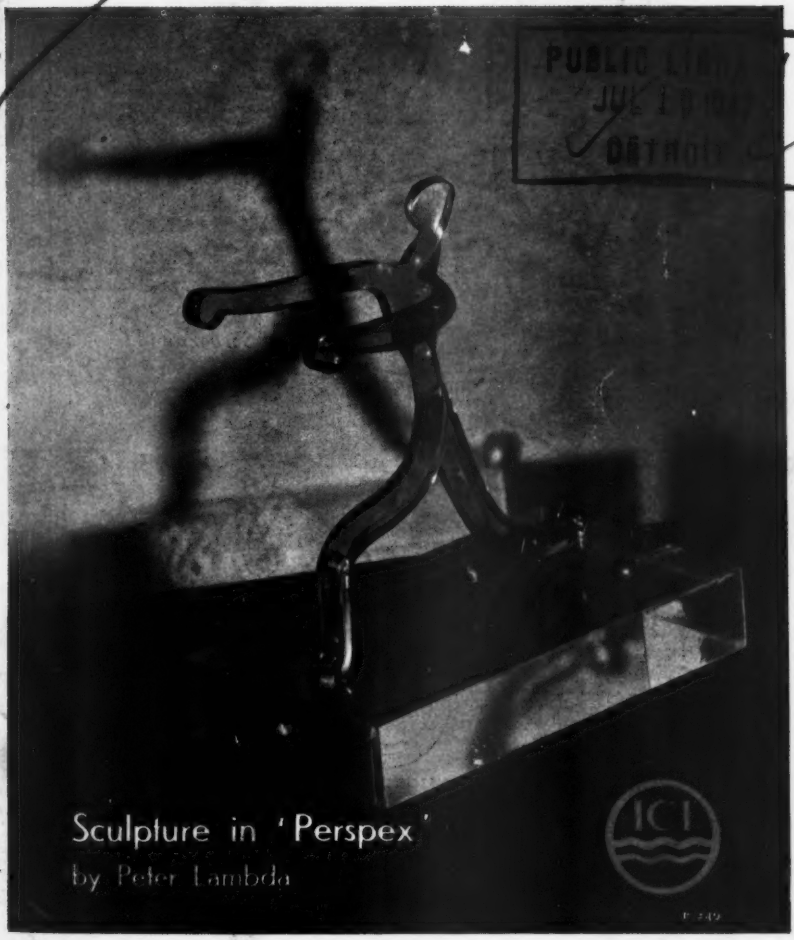

Snowshill

The pointed, grey slate roof of Snowshill church tower contrasts with the thatched cottages of Chipping Campden. The tower stops so suddenly because the money was not forthcoming for its completion.

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will it be plastic?

He doesn't know it but his dreams are made of plastics. He's going to drive a plastic train, live in a plastic house, fly a plastic 'plane. He doesn't know it, but like a lot of people he's learning to think and say, " Everything's going to be plastic soon ! " We, whose business is the development of plastics, don't go quite so far as that. What we say is this: "Plastics are not wood, nor metal, nor glass, nor rubber; nor do they imitate these familiar materials. Plastics are unique and are already established as essential materials for a wide range of manufactures." That is why our research departments are concentrating on putting plastics to work where they are not only the least expensive but also the *best* materials for the job in hand. *Ask* **BRP** *about Plastics*

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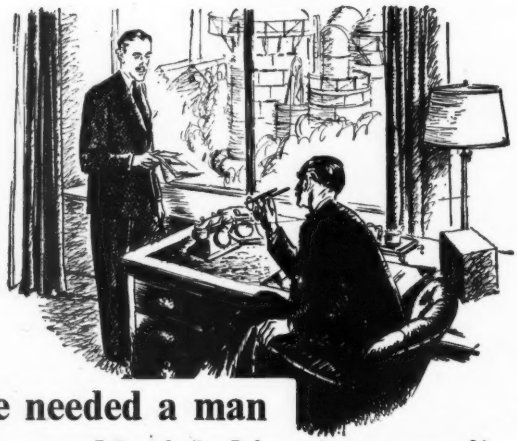

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475/P.134

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Why not discuss your particular case and problems with a Fuel Engineer who has specialised in the application of fuel efficiency to your industry? He may be able to suggest measures that would improve the whole situation, soften the fuel cut and enable you to carry on with a much lower fuel consumption per unit of output. This service is free and you have simply to telephone your Regional Fuel Office, state your problem and ask for the Service of the Regional Fuel Engineer.

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5. *Advice and personal assistance in the formation of joint fuel efficiency committees at works.*
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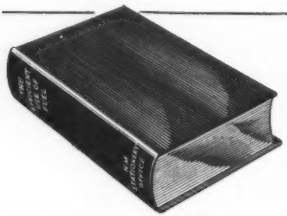

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North-Midland	Castle Gate House, Castle Gate, Nottingham	Nottingham 46216
Eastern	Shaftesbury Road, Brooklands Avenue, Cambridge	Cambridge 56268
London	Mill House, 87/89, Shaftesbury Avenue, W.1	Gerrard 9700
South-Eastern	Oakfield Court, Grove Hill Road, Tunbridge Wells	Chatham 3238
Southern	Whiteknights, Earley, Reading	Reading 61491
Wales	27, Newport Road, Cardiff	Cardiff 9234
South-Western	12/14 Apsley Road, Clifton, Bristol, 8	Bristol 38223
Midland	Temporary Office Buildings, Hagley Road West, Birmingham, 17	Bearwood 3071
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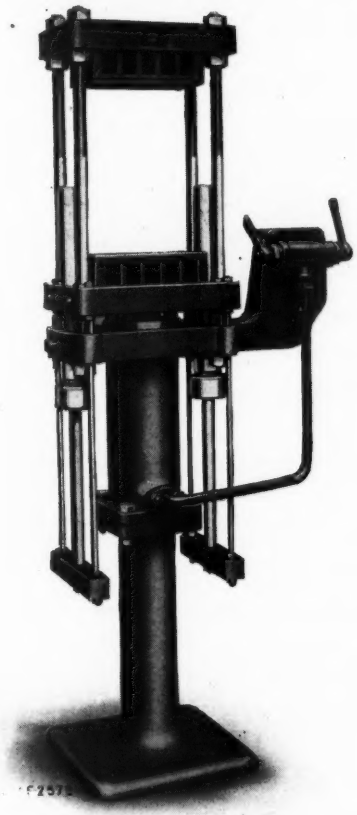

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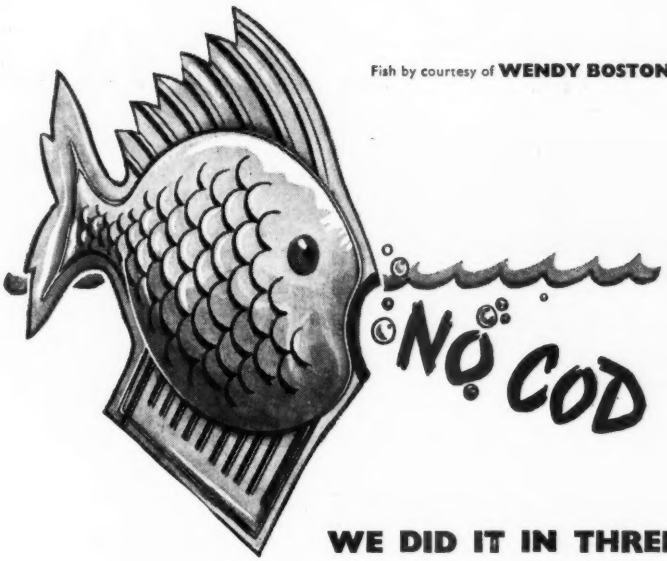

Fish by courtesy of **WENDY BOSTON** toys.

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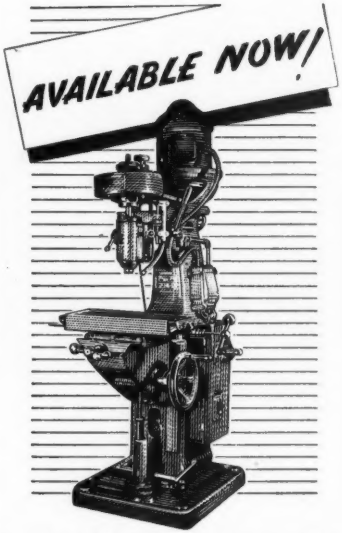

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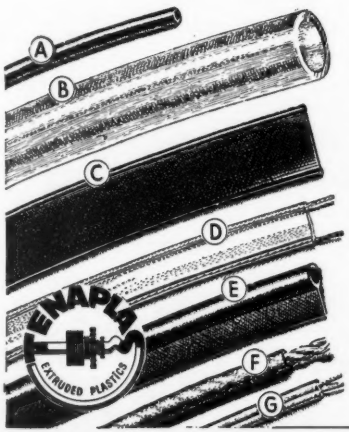

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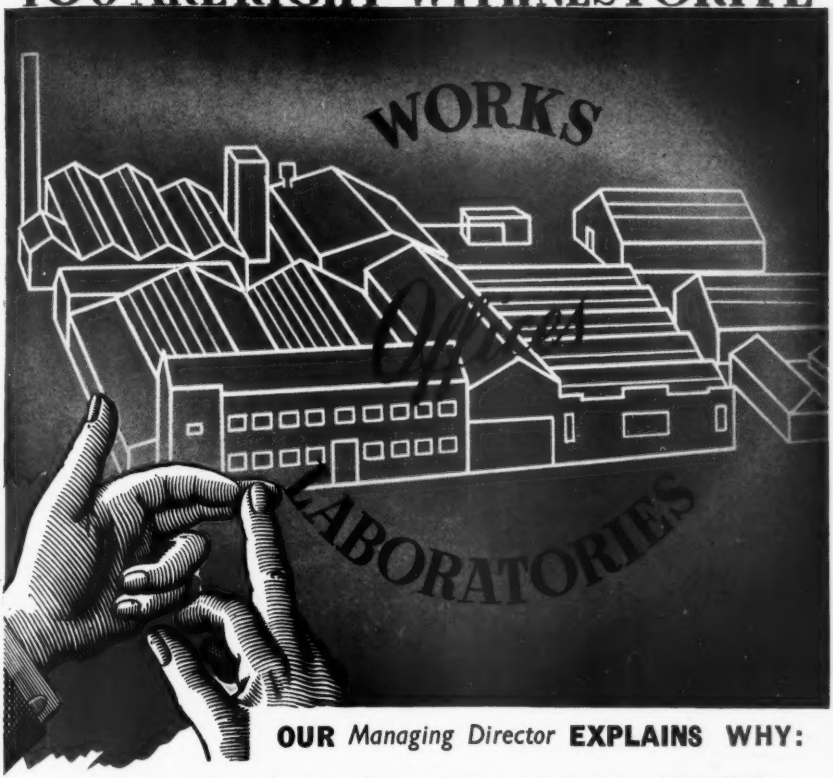

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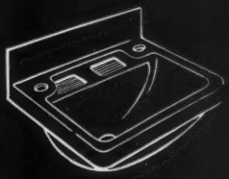

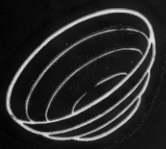

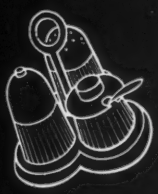

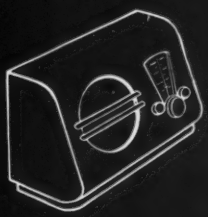

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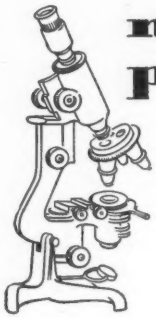

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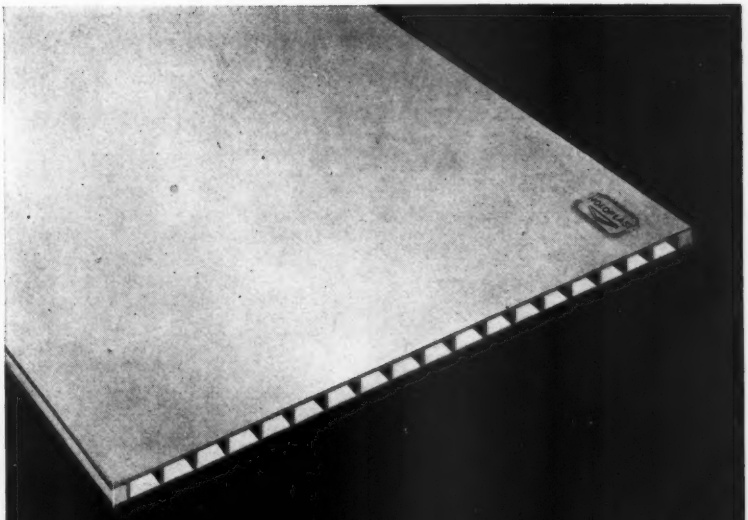

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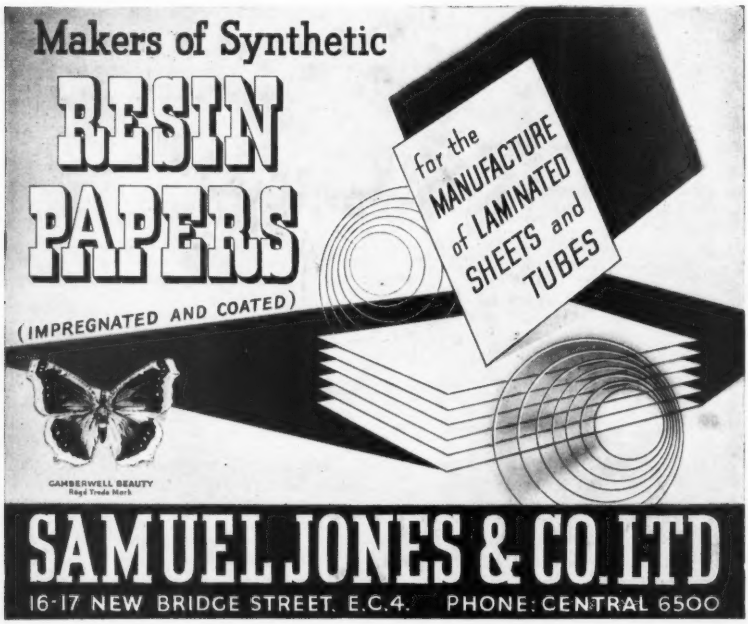
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Vol. XI. No. 122. JULY, 1947

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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CONTENTS

	Page
Editorial	338
Plastics as Living Materials, by G. H. Friese-Greene	341
Revolution in Radio Manufacture	350
Light on Black Diamonds..	352
World's Industry Employs Plastics	355
Ethyl Silicate as Bonding Agent in Mould Making, by A. E. L. Jervis ..	358
Plastics Machinery at the B.I.F.	361
Brewing Industry Looks at Plastics, by John D. Glenn	366
Synthetic Resin Bearings, by F. W. Jones	367
Plastics in Germany ..	372
Cellulose Acetate Plastics II, by Vivian Stannett ..	373
Letters	379
Production News	381
New Productions from the Moulding Shops	383
Patent Review	385
Microscopic Examination of Plastic Materials, by J. H. Wredden	387

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EDITORIALS

The Future of Plastics in Aircraft

ABOUT six years ago a very large number of the members of the Institute of the Plastics Industry braved the weather and other dangers that then descended from the heavens to listen to one of the greatest experts on aircraft construction in the country tell of his opinion of the possibility of using plastics as major constructional materials for aeroplanes.

He told us of the stupendous stresses which the big machines undergo and of the very severe conditions of sudden and extreme changes of temperature under which they fly; he also showed how much lower is the crushing strength of all plastics compared with metals, that the high coefficient of expansion of plastics was a bad thing, that low ductility or brittleness limited their use, and that repairs could not readily be carried out with plastics when enemy action had inflicted damage. In effect, he could not conceive any form of known plastics that could replace metal for the construction of wings or bodies.

That was in 1941.

In this year of grace, 1947, in the merry month of May, the Society of Chemical Industry held its annual dinner. The principal guest, Sir Ben Lockspeiser, Chief Scientist to the Ministry of Supply, related some facts about modern aircraft production.

He approached his subject first from the point of airflow and the necessity of producing smooth surfaces on wings and bodies.

It was a much simpler job, he said, to construct an aircraft wing or structure from a moulding than by means of riveting and welding, and it was much easier in this way to get the smooth surface which was so vital to economical flying. It might be surprising to know that the degree of smoothness which a wing surface had to have on an aircraft was that it must be true to .002 in. in a space of 2 ins. That was very difficult to obtain in metals which had to be riveted and welded, but it was a very simple thing in the case of a moulding. But the problem was not as easy as that because a plastic, weight for weight, was not as strong as a metal, and a copy of a metal structure in plastics would be a relatively inefficient structure.

But it was possible, he continued, to make unorthodox structures in plastics that were quite impracticable in metal, and it was possible to supply a structure that was intrinsically more efficient in this way than was an orthodox structure in metal. Moreover, it was possible to offset the relative weakness of the plastic by a new technique of construction, and a type of engineering was arriving in the aircraft world whereby the engineering structure was matched to the material and the material was matched to the engineering structure. He should not be taken as saying that aircraft should be moulded in plastics, but his point was that there were such great possibilities in the use of plastics in aircraft construction that a group of people had been got together who believed in it. By a combination of plastic sheets and paper honeycomb it was possible to produce a wing which was much more easily made and which would be just as strong as metal. This was the sort of thing that people had a habit of arguing about for years, but if it was believed in, as it was by many people, then something practical should be done about it. Aircraft designers wanted to use the space in the wings to carry petrol, and as these wings mentioned weighed only 1 lb. per cubic ft., it would be possible to make use of them for this purpose.

A new aeroplane on the lines of the

Spitfire—the Spiteful—was being designed and a wing of the type should be ready in a few months' time, when it could be tested for strength, deflection, etc., and then we should know the answer. If it only partially succeeded, it would be an advance. Even if it were made no heavier it would be an advance on metal because of the ease of construction and, in any case, it would be an interesting experiment.

This, we contend, is something very hopeful indeed for the plastics industry and for aircraft production.

It may be surmised that the honeycomb structure to which Sir Ben Lockspeiser refers is that which we described in our July, 1946, issue, which is known by the trade name of Dufaylite and is manufactured by Dufay-Chromex, Ltd. This tremendously strong, and yet very light, material was first produced here and studied very closely at Farnborough during the early days of the war. Much information regarding its production and possible use was passed over to visiting technicians from the United States in accordance with arrangements made between the two Governments. In America the Glenn-Martin Co., of Baltimore, Md., are using similar structures for the production of aeroplane wings.

Plastics as Living Materials

SOME four months ago we commented shortly on the lecture delivered under the above title by Mr. G. R. Friese-Greene before the Institute of the Plastics Industry. With the permission of that body, we have great pleasure in reproducing it in this issue in its entirety, illustrating it with photographs of some of the objects that have been manufactured by his company, J. Starkie Gardner, Ltd., of Wandsworth, London. We do not hesitate to say that it is of the utmost importance to the industry, artistically, technically and, finally, economically. This refers not merely to that section of it whose sole aim is to produce objects that appeal to the eye and which concerns itself mainly with thermoplastic materials. We believe it has a message also to all moulders of every type of raw material.

For his talk was an appeal for craftsmanship, that art which is so traditionally bound up with our industrial history—the art of working that comes with a perfect understanding of materials and long and continual manipulation of them.

We had a feeling during that meeting in February last that some of those present, while full of admiration for the lovely things displayed, must have asked themselves what they represented as marketable products, for it is obvious that all were made from an original design or model of high artistic merit, which themselves are costly. They were all made from block transparent material by craftsmen of the highest order using the slow methods of craftsmanship, entailing a "wastage" proportionate to the design, but considerably higher than that produced in what might be called the more conventional methods of the plastics industry. Indeed, it is obvious that forms and effect were aimed at, and achieved, at first irrespective of cost.

Does it pay? We hazard a guess that it does and will. It is no blind groping through the past 200 years that has built up the reputation of the concern of J Starkie Gardner, Ltd., as fine craftsmen. There is probably a reason why the company was given charge of the statue of Eros with orders to bring it to a fit state worthy of appearing in Piccadilly Circus, and why chains of office by ancient societies are being made there from silver and transparent plastic plaques inset with platinum lettering. There always will be a good and specialized market for the beautiful and the unique.

It is always invidious to make comparisons, but if we put the transparent plastic cigarette boxes seen in every tobacconist's shop (made by cementing oblong sheets of the plastic together) side by side with the one we show on page

347, is there any doubt whatever which even the least discerning would choose?

The statuettes we also show may have been carved for the sheer delight in making them. We are certain that they were produced also as a great experiment and to show that plastics can really be made to "live" just as much as marble or bronze or wood can be made to "live." It is from such experiments that the art of manipulation can be learnt and can reach its highest manifestation.

Certainly such learning has already given other satisfactory results, for the U.S.A. are extremely anxious to import thousands of the powder compacts we also illustrate, and in which etchings and silver and other precious metal wire inlays enhance the inherent beauty of the plastic. Already, too, plans are developing for the rapid production of some 10,000 carved plastic picture frames, each a delight to handle, and which have been urgently called for by foreign markets. Each will be tooled, by special machines created in the factory, from ½-in. thick Perspex "plate." These 10,000 will be produced at a rate which may well be called mass production.

What of the statuettes, and is there any relationship between them and moulding? It is obvious that such carving and tooling methods avoid the imperfections inherent in the present moulding and shaping processes from powder and sheet, which introduce changes in texture, thus diminishing the essential purity of the original raw material. This is not to detract one whit from the excellent results already obtained by the best workers using these processes. We merely wish to suggest that here in Mr. Friese-Greene's work we have the highest standard so far reached and that we should all seek to attain it.

Perhaps by making these comparisons, apparently grossly unfair, we shall so carefully study our present methods of moulding and our raw material that we shall one day improve our technique immeasurably.

It may be that this is the lesson Mr. Friese-Greene wishes to impart.

Rigid P.V.C.

CONSIDERABLE interest was shown at one of the stands at the B.I.F. of some samples of rigid polyvinyl chloride which in most countries has been synonymous with "soft slightly elastic plastic."

We welcome the details of this "new raw material" for industry that have been disclosed by Marcel Sans at the Journée Lyonnaise des Matières Plastiques recently held at Lyon, in a paper entitled "Lucoflex," the trade name given to this rigid type. Monsieur Sans is director of plastic materials at the famous Saint-Gobain works, where much research work on it and production has been carried out. Rigid p.v.c. is, simply stated, the pure polyvinyl chloride moulded without the usual addition of plasticizers or softeners which generally lower its chemical, physical and electrical properties. Rigidity and improved qualities have opened up wide and important fields beyond the reach of plasticized p.v.c.

Monsieur Sans appears to blame the war for the non-appearance of rigid p.v.c. sooner than 1938 (when the Germans were working on it), and that the world looked partly to p.v.c. to replace rubber. This is probably only partly true, for we think that the plasticized soft type still has its functions. We believe that a part of the reason for the non-appearance of the rigid type was the care needed in its make-up and the fact the plasticized variety was much easier to work on existing rubber machinery.

Thus the optimum quality for the new material is obtained with a molecular weight average of 80,000, with 20 per cent. to 30 per cent. between 40,000 and 80,000. It is also necessary to add small quantities of stabilizers and the mixture with stabilizers must be carried out to a high degree of perfection. The presence of a single non-stabilized particle can spoil a whole batch.

Chemical, physical and mechanical properties of "Lucoflex" are of especially high value; the material is available in the form of pressed blocks, extruded tubes and "profiles," and as moulding powder. A slight modification of existing injection moulding presses is necessary to mould "Lucoflex" by these means.

Monsieur Sans gave an excellent view of the new fields open to this material. It is especially useful for chemical work, that is walls and tables, piping, tiles, pumps.

Production is at present limited to such uses, but promise is held out also to the building, automobile, aircraft, furniture and mechanical engineering industries.

Plastics as Living Materials

By G. H. Friese-Greene*

WE shall, I am convinced, know plastics better and appreciate them more if we have some understanding of craftsmanship, for instance, in metal or in wood. The true use of plastics, as of iron or bronze, is best exemplified by their correctly balanced application in conjunction the one with the other.

In our national export drive it has been necessary for some of us to travel abroad, to make personal contacts, observe advances, seek information and study potential markets. My own searches over the past 12 months have taken me to Scandinavia, France, Iceland, Canada and America, and it is in the uses of the newer materials, in construction and design, that my attention and inquiries have been mostly directed. I refer to thermoplastic and thermosetting materials, aluminium, magnesium and stainless steel. Also, modern design here in this country has been strongly influenced from abroad, and it seems that many of our young designers, earnestly applying modern art to industry, have been strongly influenced by photographic records. Now the craftsman will look suspiciously at any photograph. He, like many others, knows the tricks of photography; he has been deceived too often in the past. As I did not want to be deceived, I made a point of studying modern trends by examination of actual work. Only in this way can correct interpretations of the influence of design, construction and surface finishes be made. This is where the education begins, for a craftsman wants to see and handle solid matter to be convinced of its worthiness.

Sleeping Sparrow. Carved from "Perspex" block by J. Starkie Gardner, Ltd., from model by Julia Morley.

The air of solidity in any material that is inherently strong is always pleasing, provided its surface colour and texture is allowed to express itself in a true form.

Consider a range of plastic laminated materials, metals and woods in the form of cubes, all identical in size, suitably marked and given a natural finish. Comparisons in weight and the observance of subtle differences in natural colour, density and texture by the eye and touch not only distinguishes one material from another, but promotes a greater understanding of the "personality" of all the materials. Personality

*An address given before the Institute of the Plastics Industry, London, February, 26, 1947, here published by kind permission of the Institute.

is further expressed by suggestiveness of form in design, reflecting faithfully the manipulation that has taken place to produce the form.

Now, the character of a material that builds up the personality is understood by its physical properties in the general working and processing. It is the craftsman who feels, through the touch of the tool or by hot or cold forming, for instance, the growth structure of wood, the crystalline structure of metal, or the uncrystallized structure of plastics. For demonstration, it has been possible to show only one plastic material in the workable or worked state, but the principles of design and clear expression apply equally to the full range of all the plastics, as also all materials.

We know that the essential purpose of sound design is to develop æsthetically the natural forms and qualities of the material, but this does not mean just using the material economically and with mechanical honesty. It means giving them living and poetic expression as well. Material forms are a part of the craftsman, and in design sometimes a well-detailed drawing may take another shape in his mind—his shape, for he knows the material he is going to work and the construction that will give it living and serviceable strength. So, you see, a craftsman's examination of a design may be quite critical. He is trained, however, particularly if traditional, to be an interpreter of the inspirations of others and, given reasonable freedom, he will bring out soundness of construction, subtlety of form and fineness of finish, or otherwise, that the materials demand.

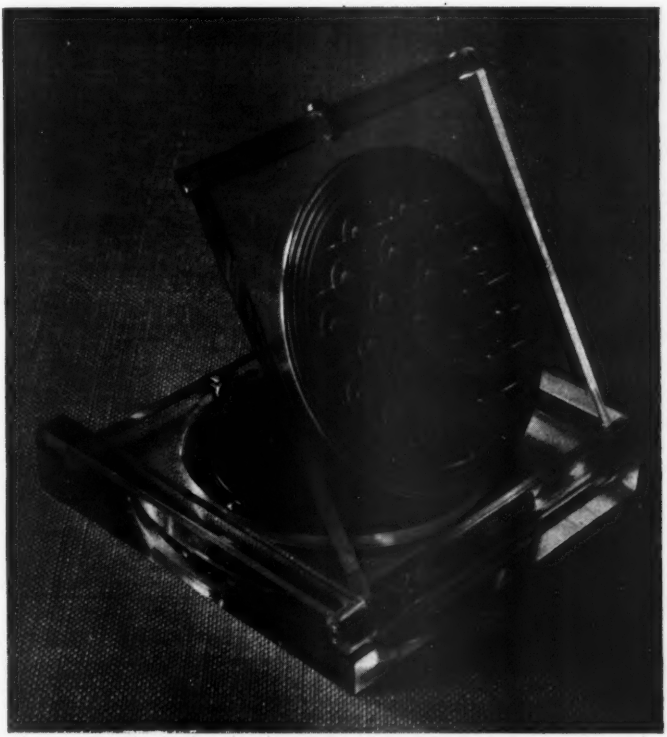
The craftsman does not wish to deceive himself nor his material. With deep sensitiveness he will try to be kind to his material, so that the material will be kind to him. All this sensitive feeling is his approach to design. It is not display, it is reality, just as the great architect always demands reality in the execution of his design conceptions, with each material being used according to its own inherent nature. So, viewing work and tastes in this country or abroad, a craftsman feels his fellow craftsman at work and is able, if versatile in the working of many materials, to win fresh technical approaches to the point of revolution in construction and finish.

To demonstrate in a very elementary fashion the implication of this outlook, examine first a powder compact made abroad in "Lucite" with simple taste and elegance. Now the hingeing in aluminium is certainly neat and unobtrusive; so far, so good. From the standpoint, however, of a craftsman experienced in the mechanical properties of this plastic, it is very much at fault. Rough use, particularly in cold weather, will almost certainly lead to rapid breaking at the point of insertion of the pins.

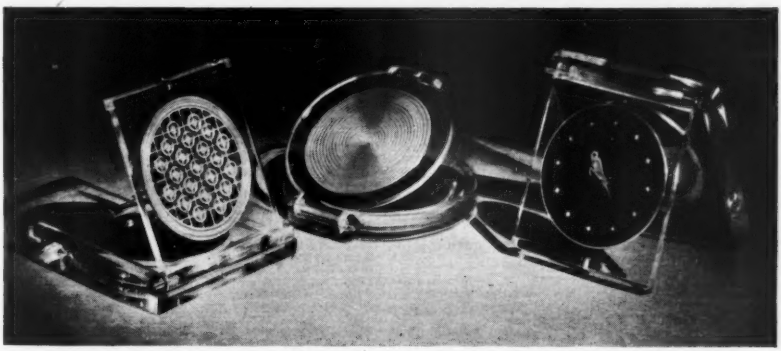
By way of contrast, let us examine another compact in "Perspex." Here, the pivots, in stainless steel, are sprung into position and located in a comfortable seating to minimize failure by any degree of normal misuse. Now, the design was evolved not by accident, but because experience has taught the craftsman that good-tempered though Perspex may be, there are some things it will not stand. The choice of metal used in either compact for the hingeing or pivoting is quite good.

These are the matters a craftsman can feel in terms of progress—judgments gained through hard experience in the workshops and through association with many materials and many processes. If imaginative, a craftsman is a disciple of constant experiment, and this is important, for theory alone will not get results. Besides, seeing is believing, and it is sometimes wise to allow a craftsman to do something that is considered wrong. It is surprising what can be, and, if we are truthful, what is, discovered by accident, and how often the impossible is achieved within a time limit. Seeking new values in a material or in a range of materials is a heritage of the British craftsman; he allows a material to talk to him.

This leads me to the important point, namely, that the craftsman is an essential



The method adopted for hinging the lid of this compact is distinctly novel and is referred to in the accompanying article.



Powder compacts designed and executed by J. Starkie Gardner Ltd., using "Perspex" and stainless steel. The "Perspex" is dyed in a variety of delicate shades.

part in design, and that his assistance should be, and, indeed, inevitably must be, sought in the guidance of the newer materials into tradition and into forms of construction. He must be free to improvise, as the idea takes solid shape, from something good to something better. Practising architects are fully aware of this, for they themselves are craftsmen in the way they produce models, and combine, build and express their materials.

At the time of all great art there have always been schools of practising craftsmen. Chippendale had his workshops, Mortlake tapestries were done in a workshop, and the Italian painters worked in schools of practical master and pupil. Our beautiful 18-century wrought iron was evolved and produced by men who learnt at the forge from Tijou. Who would think that a substance as humdrum as iron could be endowed with such a lovely decorative quality? Only a practical craftsman can decide how the mechanical stresses may be converted to decoration. A striking example of beauty in suggestiveness of form by fine craftsmanship may be seen in the " Perspex " hood to the cockpit of the de Havilland " Dove," conforming to the aero-dynamic stresses with minimum material and maximum strength.

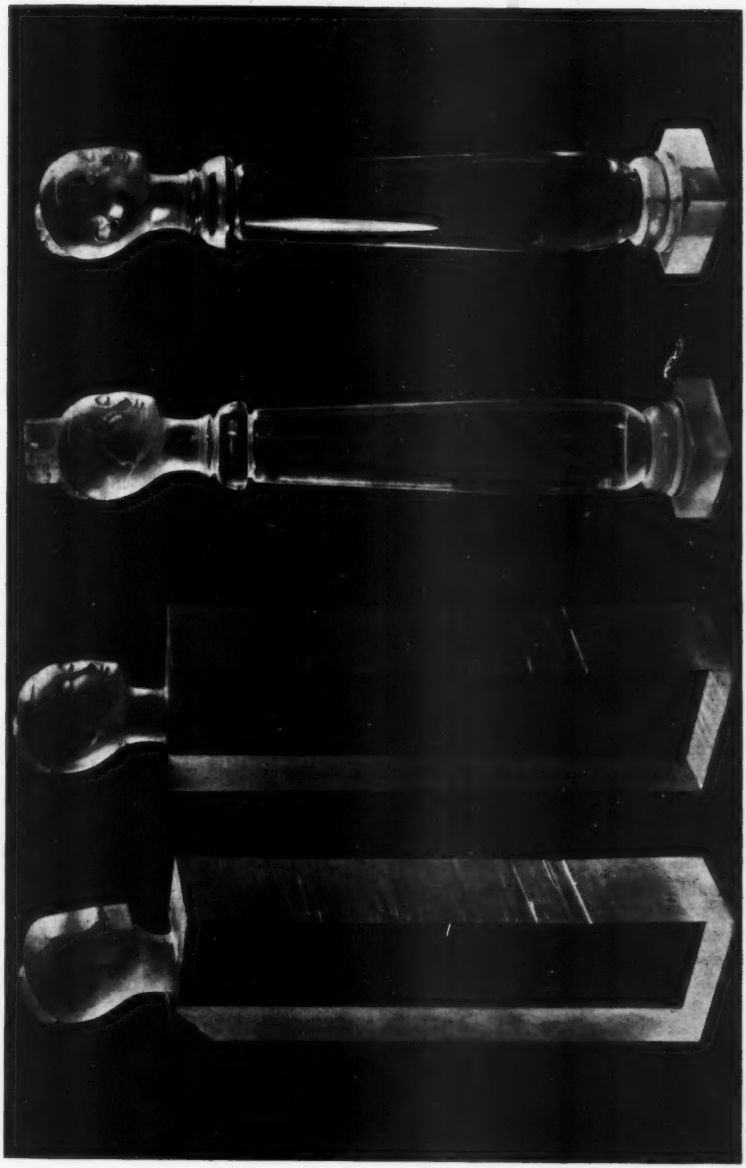
In wielding the sword on behalf of the all-round traditions of British craftsmanship, this brings me to the main purpose of my talk; that is, to drive home the vital importance of creating a traditional, yet versatile, designing team of craftsmen and technicians within all large production and fabricating organizations, where plastics and metals must take a leading part. Such a team is, and must be, the creative force for fundamental design.

Evolution, if it is to be fertile and capable of the realization of an idea in a practical, lasting form, must spring from within industry itself. Otherwise we, as a nation, will be in danger of building up a false facade over the whole of industry and the quality of our products will suffer in consequence of the imposition of tastes, shallow in root and foreign to our native soil and genius. Individual skilled artists, and good designers in their specialized groups outside industry, should be encouraged to exercise their skill and imagination on the drawing board, for in so doing they may conceivably add freshness and imagination; but here, fancy must not be mistaken for that practical ingenuity which at the last must always be called in to interpret a design and convert a mass of lines into material and three-dimensional form.

It is the designer-technician within the team of versatile craftsmen who must interpret the inspiration of the artist and, in co-operation with the craftsman, those actually handling the material, produce the form most expressive and suitable in service. It is hard and broad experience, practical knowledge and discrimination, that is needed in design more than ever to-day. This is the craftsman's rôle if we are going to maintain our national pride for good workmanship and sound products.

In handicraft it is the individual. In the industrialized product it is the technical team of craftsmen, capable of producing prototypes in a variety of materials and in close touch with technical advances, that must be recognized as the live designing force, backed by imagination from within or from without our industrial organizations. Those large factories which are willing to extend their existing toolrooms in personnel and equipment to encourage the free expression, not only in the materials usually worked, but in a whole host of materials, will benefit a thousandfold and be ready to meet the growing public need. A man of good taste in control of this team will soon stir the imagination of others to effect improvements both technically and æsthetically, and the results seen by the workers should encourage ingenuity and good workmanship.

In America and in this country such a working team would possibly be called a model shop, and should the highly skilled craftsmen be as versatile as they are skilled in handicraft, then the value of the model shop in the field of design would be increased immeasurably. For such



Four stages in carving Woman's Head from "Transpex" block, by J. Starkie Gardner Ltd., from model by Julia Morley.

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Table lamp of cast "Catalin," with stainless steel fitments and "Bexoid" shade (J. Starkie Gardner Ltd.).

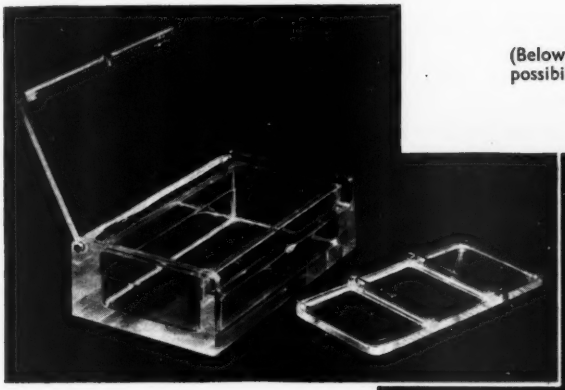
men, with encouragement, would, from sheer love of their materials, produce forms and finishes so free and natural that the living expressions would inspire the beauty and love that they themselves have endeavoured to give.

Novelties in "Plexiglas," which have been nicely worked in America, do express the material tastefully, and as such they are accomplishments; but our enthusiasm must not lead us into errors of judgment, nor must we lose a sense of proportion in focusing them into everyday life and our own traditional backgrounds. The craftsman appreciates the design and execution of this work because it inspires a train of thought leading to fresh ideas. This is very necessary when working with a new material; the period, the style, the idea, is immaterial provided the substance is worked true to itself. You will agree that door handles, fingerplates and bathroom equipment is attractive and serviceable when designed in "Plexiglas" on these lines, assets being cleanliness, lightness in weight and in effect, and unbreakable and warm to the touch, as opposed to glass. The softness of the surface precludes it from certain uses, although, if well produced and well cared for, it could be considered lasting in the same way as a highly polished surface of a dining table in wood. You will see another approach to the working of the material in pieces of carved "Perspex." The form grows through the skill of the craftsman from a line drawing, and he soon begins to understand the complications of refraction of light.

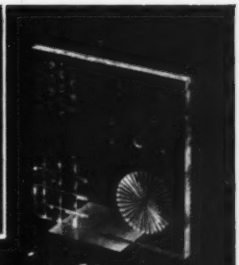
Within the large mass-production industries in America designing teams are vast in scale, with many artists and designers, innumerable specialists, technicians and skilled workers assisting in the evolution of a complete design of large and intricate assemblies. For example, the Budd Co., of Philadelphia, have brought the forming and welding of stainless steel for railroad cars to a fine art. By just a glance it can be felt that in the evolution of the design is the true expression of the material, stainless steel, the strongest of metals suitable for structural purposes. So when we are thinking of using plastic materials in design, the true expression and honest purpose of each separate plastic material should be uppermost in our thoughts. All this truthfulness of expression and honesty of purpose was in evidence on passing down the production and assembly lines, right from the delivery of the stainless-steel plate and sheet, to the completely equipped and furnished carriage.

Wherever I have been throughout Europe and America there may have been as many as a thousand draughtsmen engaged by a single organization, but when a design is finished on paper in any one of the factories, the draughtsman goes into the workshop to consult Bill or Harry, the practical man on the spot, the man with years of experience. From that moment the design begins to live.

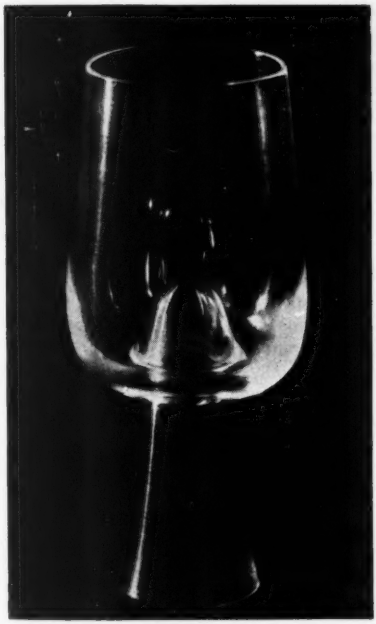
What impressed me so much in America was the personal enthusiasm of



(Below) Examples of the possibilities in machining plastics.



(Above) Cigarette or trinket box cut from solid "Perspex." Hinges and pins are of stainless steel.



Prototype goblet machined from "Perspex" block.

individuals, whether in large, medium or small production workshops. The newer materials have infused a new spirit to their industry and given such confidence that experiment for progress is going on at a rapid pace. The work of the laboratory and the practical and tested service of the newer materials in war have inspired the men of courage and enterprise. These men are giving direct, honest and emphatic expression to their materials, not only in civil and naval architecture, but in domestic and everyday commodities as well.

New and vigorous schools of thought are growing up. We know this is happening in England, but I am convinced that so-called design applied like a poultice to industry is extremely unhealthy unless balanced by the anti-bodies of live designing forces from within industry itself. Both schools together can be imaginative, both together can be con-

structive, but industry cannot at any time afford to lose confidence in its own creative power.

In design let us be sure we remain British and take steps to preserve characteristically British qualities in what we may term "light engineering" and "architectural" applications. To be British in design does not necessarily tie a label to any period or taste, but it does mean that the good quality and solid service factors must evolve out of hard practical experience, as in the past. After all, British goods up to the outbreak of war were considered abroad some of the finest in the world. I am sure they still are in most industries, but we must not expect too much assistance from outside, for the industrial designer may apply a superimposed taste that can easily wither in years of service. Besides, there is the time factor. We have little time to lose in teaching by letter or by display so much that is more normally acquired by practical experience.

The industrial designer is to be regarded carefully unless he can prove that his own feet have long been implanted on the solid rock of practice, or you are sure he is backed by a vigorous team of technicians and craftsmen. Here there must be an honest desire for a genuine partnership, and there must be equal recognition. Only then can artists and designers dealing in the higher æsthetics be welcomed with greater understanding for the common good.

The human approach in design can be revived through handicraft, through pride in personal skill. With all the craftsman's evolutionary experience in the great engineering industries of the 20th century, he realizes that there is, in theory and should be in practice, little contra-distinction between industrial art and handicraft. Art applied to industry, the slogan we hear so much about to-day, can have little meaning unless this underlying significance be appreciated and the heart of the craftsman is in tune. We are in danger of artificiality and the newer materials will suffer most of all unless the craftsman's understanding in design is properly sought and fostered.

Now, the newer materials have got to be understood, not only by the engineer with his mechanical mind, the chemist with his analytical and synthetic outlook, or the physicist with his insight into their internal make-up, but, furthermore, by the craftsman, who is called upon to shape them with his hands and who soon develops a deep knowledge of those minute differences in workability. This is important, for the time is opportune for us to examine quite closely, in the light of the new materials, this difference which may exist between the designer, considered purely as such, and the true craftsman.

Unfortunately, certain characteristic trends in the development of our manufacturing organizations have resulted in the creation of narrowly specialized schools of design. Within the boundaries of these schools we are perfectly safe. The schools do, however, lack that broadness of outlook, and this is rather dangerous if they are called upon to cope adequately with materials outside their own immediate sphere. Here, I suggest, lies the crux of the whole trouble.

Industry to-day is not short of industrial designers, but as a result of misapplied specialization it does lack that all-round knowledge and sensitivity to actual contact with material things which is the heritage of the craftsman, and which does, in fact, give him such insight into the true fundamentals of design. For example, many of our designers have only really specialized in a single range of commodities, such as pottery, and their taste and style in design has been wrapped around the workability of that basic material. When they widen their scope with other materials they may only effect superficial changes in form, and wonder why they have not been so successful in their new ventures.

The versatile craftsman is the consultant here, for he knows the subtle differences that matter when varying the form of one material for another, and it

is he who can make one material live with another in its construction and its finish. This cannot be expressed on paper. Take colour, for instance; despite the tedious efforts of science to reduce it to a system, colour will not yield up all its secrets, for living colour is defined by texture, finish, form and light. It is the craftsman who will feel the colour values, as he fashions his material, and in the final forming the delicacy and subtlety of a line can be made or lost by the pressure of the hand. Also, the craftsman trained to tradition and versed in handling the older materials is able to discriminate and advise on the new materials by contrast in working and by association in actual experiment.

May I quote here a simple example to illustrate more fully what I mean? It is customary to-day, even to those who should know better, to talk glibly of plastics as though they constituted an harmonious family, differing but little one from the other. There is no need for me to point out the error, and certainly nobody realizes better than the craftsman the immense gap which separates the working properties of, say, a synthetic plastic of high impact strength, such as a phenolic lamination or even celluloid, and a natural plastic, namely, amber, with its lamentably low impact strength and non-uniformity of mechanical properties.

The ability to discriminate is becoming more than ever a vital factor in design, for we are living in an age of specialized materials. Down the ages, the older materials have been allowed to express themselves through the imagination, skill and genuine feeling of the craftsman in handicraft. The great artist is also a craftsman, for he applies his materials with inspiration, but he must have personal skill. The genius breaks all the rules, but he learns them first. In the realm of fine art plastics will live on, not because of their seeming imperishable chemical nature, but by reason of the truth that the creative artist and craftsman portrays.

The tendency in big industry in this country, sponsored by raw-material suppliers and even suppliers of the semi-wrought product, has been to specialize its design and sales policy on the single substance or range at its command, instead of creating a craftsman's team used to handling the fullest possible groups of materials. I am a firm believer that we have reached that stage in the world industrial revolution when the highly skilled and versatile teams of designers and craftsmen will play one of the most important parts in the greatness of a nation, just as the individual craftsman in handicrafts, through his ancient guilds, made England's earlier greatness in commerce. In mass production we cannot compete with America, but we still have our priceless tradition of skilled handicraft and small, versatile, working units. It is from these that we must rapidly evolve before we lose the advantage of our technical achievements.

It is up to our teams of designers and craftsmen to produce a quality of goods which can admit of no loose thought, but which, whether exposed for sale in London, Paris, New York or Pekin, inspire confidence by their balance between art, material and workmanship.

Design, scientifically directed through the drawing and designing offices of industry or by the independent experts trained to line, composition and form, is not enough, for such direction must be balanced by the practical team of versatile craftsmen as a recognized live force. Perhaps one day we shall all see these truly wonderful materials, plastics, that are produced by the chemist, and whose physical properties have been divulged by the physicist, completely understood, not only by the fabricator or, say, the modeller, carver, engraver and turner, but also by the worker on the high-pressure and ejection moulds. Then the utility and beauty of plastics as living materials will not only capture the public's imagination, but assure a future far beyond the dreams of the scientists and chemical engineers who create them.

Revolution in Radio Manufacture

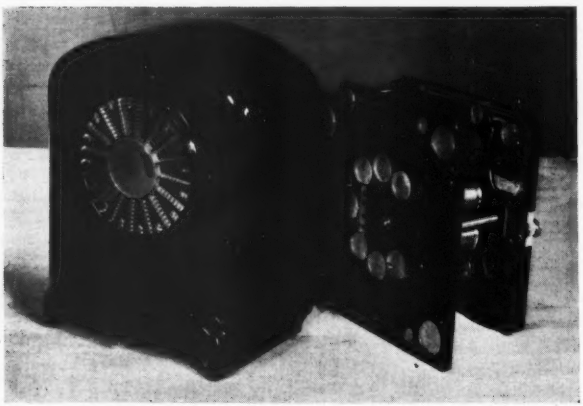
THERE is a good deal of truth that this country is far behind many others in mechanized production. This is a general statement of our position which is gradually being improved and in what follows we give an example of an entirely British system which may well be the envy of even the U.S.A.

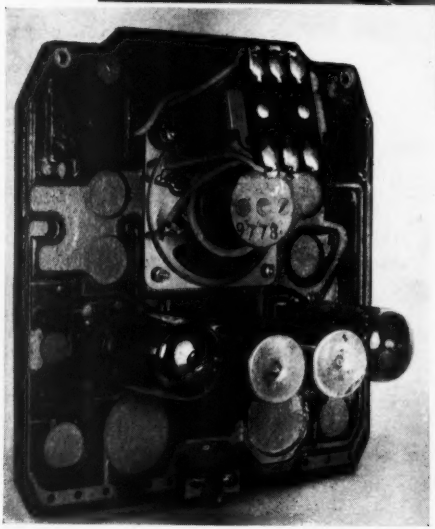
It is one which produces the complete circuit of a simple radio receiving set every 20 secs. in a machine some 70 ft. long controlled completely automatically at every stage by electronic means. The raw material that passes through it is a panel of Bakelite resin moulded by British Moulded Plastics, Ltd.

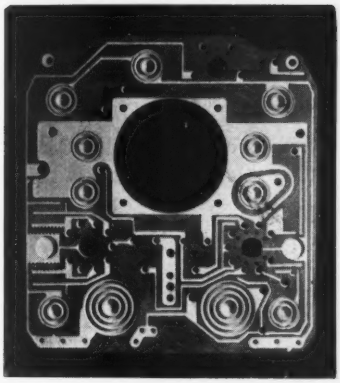
The new invention by John A. Sargrove, M.Brit.I.R.E., A.M.I.E.E., of Sargrove Electronics, Ltd., of Walton-on-Thames, discards completely the conventional methods of circuit building. The plastic panel moulded from Bakelite X20 H.D. resin powder, a material especially designed for improved electrical insulation, is received as a moulding some 6 ins. by 6 ins. by ¼ in. thick, provided with fine grooves, depressions and webs. After it has passed through the electronically controlled machine where the grooves, depressions and webs are filled or coated with metal, the plastic panel, still ¼ in. thick, issues as a complete compound circuit containing wiring, switches, resistors, tracks, inductances, etc. Almost all conventional components are thus eliminated, the panel thus becoming the main structure and bearer of the above components which are one with it, in addition to acting as the dielectric in which all are built. Since all or most of the conventional components have "disappeared," the interior of the receiver appears almost empty when compared with the ordinary type of apparatus.

While the idea of such incorporation is not new (attempts have previously been made with ebonite and porcelain, and also the use of "printing" the components with metal "inks"), the advent of the resin-moulded panel has enabled high-quality production to be attained. This, together with the amazingly brilliant electronic machine, which alone deserves a special description, allows for production on exceptionally high rate at a cost very much below present prices for receivers of similar size.

The only personnel employed at the machine are at the feeding and receiving ends. The moulding is first fed through an air lock to a shot-blasting cubicle, the presence of it being registered photometrically by a master control unit. When a panel is absent no blasting takes place, but it commences automatically when the panel enters the cubicle. The moulding with its roughened surface then passes through a second air lock to the metallizing chamber, where twin metal spraying pistols (designed by



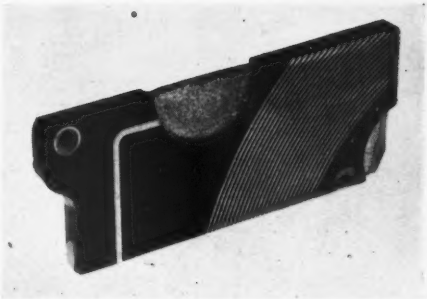




(Top) The automatic machine making complete radio cabinets.

(Centre) The metallised Bakelite plate and the complete panel.

Metallisation, Ltd.) commence operations, blowing zinc metal on to the whole surface. In another cabinet excess metal is milled off, leaving metal in the grooves, the plate then passing on to a graphite-spraying cubicle for the formation of resistors. Even the insertion of sockets for valve holders is carried out by welding and riveting automatically.



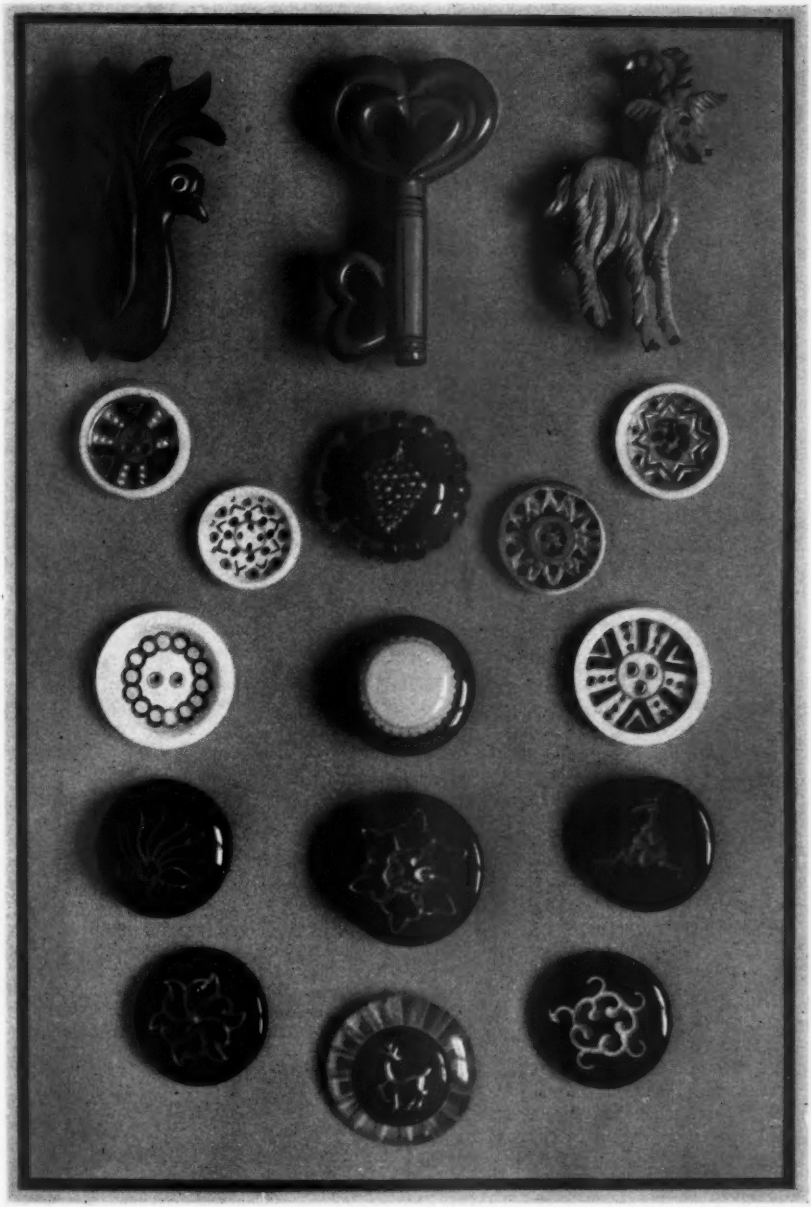
Part of plate showing grooves and webs which form inductances and condensers.

IN the county of Durham there is a small town, Bishop Auckland by name, famous for the palace of the Bishops of Durham, and, until the beginning of the 1930s', industrially known only for its collieries and ironworks.

About the year 1937, when the Government was sending urgent appeals for industry to help the distressed areas, more especially by the introduction of light industries, Messrs. Ernest and Henry, Ltd., decided to transfer their entire business to Bishop Auckland from London, where they had manufactured since 1933.

Theirs was indeed a light industry, for, armed with a superb knowledge of the machinery, technique and raw materials involved, they proposed setting up a factory for the production of plastic buttons, plastic "jewellery," dress decorations and similar fancy goods.

Examples of brooches, ear-rings and buttons produced by the special reverse-engraving process described in these notes.



Modern buttons and dress ornaments cut and drilled from casein and "casein-Perspex" combinations.

The worker presses the "Perspex" block or sheet against an inverted drill, and by her manipulative skill and without an indicated design, produces a work of art.

To-day, the firm of Ernest and Henry, Ltd., employs some 250 girls and women and men in an area where industrial employment of women had been almost unheard of, and in an industry where the work is not only healthy and pleasurable, but gives the workers the opportunity of individual effort and skill in design that is rare in any branch of work. The raw materials are "Perspex" and casein sheet, so that it can well be imagined that the workers take an excited interest in the handling and making of the colourful flow of new designs that incessantly stream through the factory.

The button section of the works is unlike the ordinary button factory where the designs are simple and strictly utilitarian, where the production is often of the order of a million a day, and is, therefore, completely mass production.

In this factory, each button, or, rather, range of buttons, is so designed, cut, turned, drilled and colourfully composed that each is not merely a button but also an individual accomplishment—a decoration.

On the other hand, so full is it with the most modern of high-speed tools, we also get the impression of mass production. It is, indeed, the happiest combination of these two types of industrial effort we have yet seen.

The height of individual accomplishment and manipulative skill is, perhaps, most vividly seen in the production of transparent buttons and brooches made from "Perspex," and exemplified in the "violin" dress decoration which was admired at the recent Plastics Exhibition.

The training for this type of production takes some considerable time, and, as can well be imagined, is eagerly sought for. Obviously, females excel in this delicate work. The machine resembles an inverted dentist's drill, the shaped piece of "Perspex" being held in the hands and pressed against the grinding head, working, so to speak, in reverse. The turning and twisting of the hand, the depth to which the drill is simultaneously forced, produces, coupled with the remarkable physical properties of the plastic, an effect simulated by no other raw material. The rose design, here so happily reproduced, is typical.

Most of the buttons and ornaments, which are mostly multi-coloured, are similarly produced, that is, individually fabricated from the sheet by sawing, turning, drilling and polishing on the most modern high-speed tools. It will be readily seen from the photographs shown how much "hand" work is carried out on each object; that each is, in effect, an individual design and incapable of being fabricated by mass production.

We are indeed glad to welcome industries such as this, for it introduces a type of high-class craftsmanship which, generally speaking, was left to Central Europe in pre-war days. It is of special importance from the export point of view.

"**FLOATING EXHIBITION.**"—Four thousand visitors attended Britain's first post-war "Floating Exhibition" aboard the M.V. "St Merriel" during the three days it was on view in Rio de Janeiro, the first port to be visited in South America. Among the exhibits is the plastics moulding machine of Reed Brothers (Engineering), Ltd. So many inquiries were received for the various products exhibited that it will be necessary for the Organizer, Mr. R. M. S. Morrison, to return to Rio when the "Exhibition" has completed its tour. The next port of call was Santos, where the exhibition was equally well received. The "St. Merriel" has yet to visit Rio Grande do Sul, Montevideo, Rosario, and Buenos Aires.

World's Industry Employs Plastics

GENERAL ENGINEERING

Working data for acrylic-resin sheet receives particular recommendations as regards turning, routing, drilling, tapping, jointing, cleaning, polishing and other operations in "Mechanics" (1947/May 2/10).

Automatic machining for laminated plastics is described by K. Rose ("Materials and Methods," 1947/May/73). The abrasive nature of these materials necessitates the use of sintered carbide and diamond tools.

Bondimeter, a new instrument developed by the American Instrument Co., Silverspring, Md., permits the detection of faulty bonding in laminated materials, such as plywood, veneers, laminated plastics and metal plastics. The instrument, which is cup-shaped, is placed on the material to be tested and a vacuum is created. Under these circumstances the material is caused to bulge and the deflection is measured by a dial gauge. Faulty bonding results in larger deflections. ("Materials and Methods," 1947/May/140.)

Bonding of metals to non-metallic materials is surveyed by T. Waterfall. ("Practical Engineering," 1947/**15**/304.) The most satisfactory results appear to be obtained when rubber and plastic adhesives are combined.

Testing representative samples of typical commercial plastics by several methods which relate to test properties associated with hardness and abrasion resistance, including indentation, scratch and wear methods, L. Boor and collaborators recognized five different aspects of behaviour. (A.S.T.M. Bulletin, 1947/68.)

Polishing and buffing costs are reduced by proper selection of compounds and wheels for each particular type of plastic and by a special sequence of operation. When polishing coloured plastics, compounds should be added to match the particular shade concerned. Buffing speeds should be kept between 3,000 and 4,000 ft. per min. ("Machinist," 1947/April 19/2,120.)

Developments in jointing of plastics, such as the Redux bonding process, and the use of Kraft paper for producing "Holoplast" structural plastics, are described by W. Nichols. ("Machinery Lloyd," Continental Edit., 1947/May 31/38.)

Acrylic resins have been produced in form of corrugated sheets, thus providing thin sheets in rigid nature. Applications include baggage racks in buses or trains, a thickness of 0.080 in. of plastic being able to withstand impact of a 25 lb. lead weight. The corrugated sheets support such weights without visible deflection. ("Scientific American," 1947/May/224.)

Transfer moulding on a large scale is discussed by M. Freund, who shows that this process can now compete with the orthodox compression moulding in economy and efficiency. (Proc. Inst. Mech. Eng., 1947/**156**/43.)

Mechanical principles of screw extrusion machine are described by Z. M. Rogowsky, who develops a dimensional analysis giving general relationship between pressure developed, rate of discharge and driving power on the one hand, and viscosity of plastic under extrusion, speed of machine and a characteristic dimension. (Proc. Inst. Mech. Eng., 1947/**156**/56.)

Basic information on plastics for the engineer who does not commonly work with these materials is given in an 18-page Manual compiled by K. Rose. All types of plastics at present available are described and their chief uses indicated. Trade names, as used in America, are listed. (" Materials and Methods," 1947/April/119.)

CHEMICAL

Triethylhexyl phosphate, a plasticizer for vinyl plastics, is to be produced by the Carbide and Carbon Chemical Corporation and sold under the trade name of " Flexol." It is said to impart improved flexibility at extremely low temperatures and to provide flame resistance. (Betro Review, 1947/June/24.)

Trioxane, a polymer of formaldehyde, although discovered in 1885, has only recently been commercially produced. It is able to replace aqueous formaldehyde solutions or other formaldehyde polymers, whereby the resulting products are improved. (" Scientific American," 1947/April/179.)

MISCELLANEOUS

Gramophone records, claimed to have technical superiority and capable of being produced at reduced manufacturing costs, are to be made with new plastic substitute for shellac produced by Drumor Plastics Inc., of New Jersey. (Betro Review, 1947/June/24.)

New powder dyes can be used with cellulose acetate, polystyrene, acrylic and vinyl resin moulding powders. Light shades can be produced with these new concentrate moulding powder dyes by adding as little as ½ to 1 oz. of the dye to 26 lb. of moulding powder. The colours available range from yellow to bluish-green, all of which can be intermixed. (" Machinery," N.Y., 1947/May/177.)

Vertical injection-moulding press, developed by Giddings and Lewis, should facilitate the clamping of the mould halves. The material is injected in one stroke of the piston. Owing to the better accessibility, the change-over time of moulds is reduced to about 20 minutes. (" Machinery," N.Y., 1947/May/190.)

Display bottle, measuring 3 ft. high and 1 ft. diameter, has been fabricated by Arnold Plastic Co., using ¼-in. thick acrylic resin. It is processed inside to simulate a label. The cap is of opaque acrylic material. (" Scientific American," 1947/May/216.)

Pallets for lift trucks are now constructed with ⅝-in. plywood decks and posts, having only about half the weight of comparable hardwood constructions. The Clark True tractor unit is double-faced and designed for four-way fork entry. (" Autom. and Aviation Ind.," 1947/May 1/48.)

Silicons are to be produced on a large scale at Waterford, N.Y., by General Electric Co. The development of a variety of automotive applications is anticipated. The latest product is a paint for trucks and motorcars. (" Autom. and Aviation Ind.," 1947/May 1.)

Car bodies were to be constructed of Conolon plastic, a by-product of " Metlbond " high-strength adhesives, according to intentions of Bobbi Motor Car Corporation, but the idea has been temporarily abandoned. The tooling of this material, however, is described by Th. A. Dickinson. (" Tool Engineer," 1947/April/35.)

Defects on surface of plastic moulds, may, according to R. J. Hoensheid, be due to poor carburizing practice. This may be partly offset by proper steel selection and efficient polishing procedure. (" Machinist," 1947/May 3/24.)

Bibliography of advances in plastics, by H. M. Richardson, covers new materials, applications and equipment. A Bibliography of 118 references is appended (" Mechanical Engineering," 1947/May/370). A similar review on rubber (172 references), by E. F. Riesing and J. O. Callouette, deals mainly with tyre production, research development, processing and testing improvements. (" Mechanical Engineering," 1947/May/373.)

Decorative plastic parts made by amateur experience in moulding involves the use of moulds of plaster of paris or of dental plastics. (" Mechanics," 1947/April 18/514.)

High-frequency heating for plastics is surveyed by E. Roemer, with a study of foreign literature upon this subject. (" Kunststoffe, 1946/**36**/8.)

Combined oven and refrigerator for testing the strength of plastics at temperatures from 50 degrees below zero to 200 degrees F. has been developed by Westinghouse Research Laboratories. Main purpose is to test the strength of Micarta plastics as used in engine gears and aircraft parts. (" Machinery " (N.Y.), 1947/March/173.)

Nylon staple fibre is to be in limited commercial production this year, where hitherto produced experimentally. The new fibre will be available in short and fuzzy lengths for use alone or blended with other staple fibres. (" Scientific American," 1947/May/219.)

Scrap acrylic material from airplane construction is now being turned into a sheeting called " Mottletone "; it has the appearance of onyx, and is available in a wide range of colours. (" Scientific American," 1947/Mar./115.)

Fully hydraulic injection moulding machine of 4-oz. capacity, with a working pressure of 2,250 lb. per sq. in., announced by Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has simplified construction and incorporates newly designed hydro-power booster. (" Machinery," N.Y., 1947/April/197.)

Giant injection-moulding machine, capable of moulding pieces up to 32 oz. over a projected area of 150 sq. ins., is produced by Lester-Phœnix Inc., Cleveland, Ohio. (" Machinery," N.Y., 1947/April/200.)

Transparent plastic " paper," a new adventure in trade literature, allows the reader to dismantle the illustration of a " machine " as he turns the pages. (" Machinery," N.Y., 1947/April/232.)

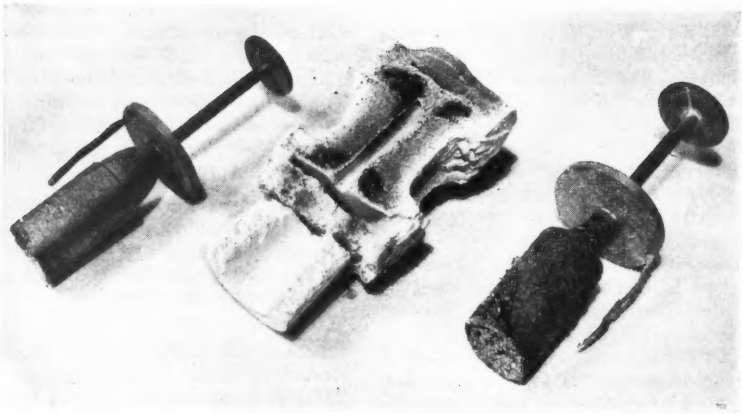
Latex-dip coatings are discussed in " Products Finishing " (1947/May/74). The coatings can be resistant against oil, weather, light and medium concentrations of acids or alkalis. Important applications are electrical insulations; also trays, racks, etc., to reduce noise and breakage.

Moulding powder " Phentor," developed in Australia, incorporates a naturally occurring filler. The powder also contains a thermoplastic constituent which remains slightly soft until the moulding has cooled. It is emphasized that this softness is not under-cure. (" Chemical Age," 1947/May 4/675.)

Lawn mower with Tenite roller of three moulded sections shows greatly increased life. Water- and shock-proof, the plastic is undamaged by moisture absorption, pebbles or sticks hidden in the grass. (" Machine Design," 1947/April/175.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.



Aluminium and brass test pieces cast in mould made with ethyl silicate as bonding agent.

Ethyl Silicate as Bonding Agent in Mould Making

By A. E. L. Jervis

Organo-silicon compounds are proving to have extremely useful properties of heat endurance, elasticity and waterproofness not possessed by any natural products. This article deals with a useful application for ethyl silicate, and includes a few notes on silicones and related products.

THE commercial value of ethyl silicate hinges upon its ability to deposit silica. As far back as 1860 it was suggested by Hoffman as a means of preserving the stonework of the Palace of Westminster. In contact with water, the ethyl silicate slowly hydrolizes to silicic acid and ethyl alcohol. The silicic acid in turn dehydrates to an "adhesive" form of silica, which is extremely resistant to many chemicals and to heat. The commercial possibilities of this reaction are far-reaching.

Because it is a very convenient silica-depositing medium, ethyl silicate is not only useful for preserving masonry, concrete, plaster, etc., and as a weatherproof ingredient of mortars and cements; it also finds use as a bonding agent.

It has been known for some time that refractory bodies can be obtained by binding a filler, e.g., sillimanite, by means of a silicon ester, i.e., the product of silicic acid and alcohol. The ester, ethyl silicate, for example, will react with water under certain conditions to form a strong gel of silica, and will bind the sillimanite together by means of the deposited silica. The body thus produced can then be baked to give a strong, hard article.

Readers may already be acquainted with the limitations of moulds made with plaster of paris. In contrast to these, moulds made with ethyl silicate plus sillimanite have stood up to the pouring of molten metal at temperatures as high as 1,600 degrees C. There is little dimensional change during the mixing and firing.

The so-called "lost wax" process (cire perdue) process of precision casting is one of the oldest processes of casting. It was used by the Chinese and the Greeks many years before the Christian era. Then for some centuries the art of casting by

this method seems to have been lost. It is sometimes suggested that the inclusion of the word "lost" refers to this fact, but it is more probable that it refers to an actual loss of wax during the process, although in modern practice a special wax compound is selected, having a low melting temperature, small shrinkage, and hard finish.

Medieval metal statuary was often produced by this technique. During World War II the process became vitally important in a different direction, for it was applied in the production of gas turbine blades. One firm claims to have made five million blades by this process.

Now, why was this particular process employed? For gas turbine work, special alloys—which are difficult or impossible to forge or machine—are used, and with precision casting the blades were sufficiently accurate in the unmachined state.

With the process under discussion, a very clean "unmachine" finish can be produced, and an accuracy of plus or minus 5 thou. per inch is obtainable in mass production. For large quantities of parts made of very tough material the process therefore seems ideal.

Before proceeding to a brief description of the process typically applied, it should be emphasized that the process is not confined exclusively to the mass production of small components, but has also been used for castings as heavy as 15 lb.

In this particular process the idea is to make a wax model of the metal article required, and to use this wax model in forming a mould. This is not quite so simple as it may sound, and the following schedule of operations is given for the benefit of readers.

(1) A copy of the article to be produced is made in metal or other suitable material, the dimensions being arranged to allow for shrinkage.

(2) A bismuth-alloy mould is formed round this master replica in two or more sections in conventional manner, leaving "gates" for pouring.

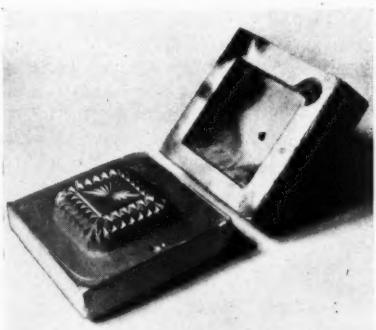
(3) The master replica is then removed and the cavity which it formed in the mould is evacuated under vacuum.

(4) The wax pattern is then produced by forcing wax into the cavity, under pressure.

(5) The wax pattern is removed from the cavity and is sprayed with a fine fluid mixture of the refractory materials, which is then allowed to dry off.

(6) An investment mixture is made, consisting of ethyl silicate, sillimanite or other suitable filler, and a controlling agent, in slurry form.

Steel mould and refractory mould for glass dish.



Typical refractory mould for a butter-dish.

(7) The coated wax pattern (5) is placed in a metal flask, and the flask is quickly filled with the wet investment mixture (6).

(8) The flask containing the pattern and the slurry is now vibrated for some time, in order to remove air bubbles and keep the slurry settled down around the pattern. The setting time depends, naturally, upon the mass of the mould.

(9) The slurry cold-sets to form a mould, and this mould is then baked in order to melt the wax, which comes out through the pouring gates, and also to harden the mould.

(10) The time has now come to melt the metal, which is to form the final article. This is done in an electric-arc furnace, to the top of which is clamped the refractory mould with its "gate" over the pouring spout of the furnace.

(11) The chamber is tipped up and air pressure is used to force the molten metal into the mould.

(12) When the assembly has sufficiently cooled, the refractory mould can be separated from the metal casting.

Silicones

The materials known as silicones had their genesis just after the close of the 19th century, when Dr. F. S. Kipping, professor of chemistry at the University of Nottingham, was intrigued by the similarities of the elements silicon and carbon. Silicon lies in the same group and next to carbon in the periodic table; both have chemical valencies of four, and share other chemical likeness. Kipping, therefore, wondered, as had other chemists before him, if it would be possible to make a semi-inorganic product in which a carbon atom would be replaced by one of silicon; in brief, could he make silicon analogues of hydrocarbon compounds? In this he was indeed successful, and the numerous silico-ketones which were made have now become known as silicones.

The silicone fluids are much less volatile, have higher flash points and fire points, and are more oxidation resistant than petroleum oils of equal viscosity. They also thicken less at low temperatures and thin out less at high temperatures.

From America, some time in 1943, came the news of the first commercial production of heat-stable, organo-silicon-oxide polymers in the form of fluids, greases, insulating resinoid, and high temperature lubricants. These new silicones have excellent dielectric properties and are stable at temperatures well above the maximum laid down in specifications for any organic insulant. What this means, for example, in the design of an electric motor permitting considerable reduction in dimensions, of a larger output from existing frame sizes, again confirms the truth contained in the much-quoted statement that progress in the electrical industry can best be assessed by the progress made in the field of electrical insulation.

It has now become possible to produce silicon-oxygen-silicon structures similar to those previously known in high polymeric materials only in the field of inorganic high polymers such as glass, vitreous silica, quartz and asbestos.

Interesting developments have also recently shown that cellulosic materials such as sawdust, wood floor, paper, cotton, wool, etc., can be bonded together with modified silesters, either in sheet or in powdered form. The resultant materials are dense, free from grain, and readily machinable. The curing is based on the ester interchange reaction between cellulose and the silester resin under heat and pressure, in a manner similar to techniques used for phenol formaldehyde resins.

HANOVER TRADE FAIR.—The first export Trade Fair for the display of goods produced in the joint U.S./U.K. Zones of Occupation in Germany will be staged in the Vereinigte Leichmetall Werke factory at Laatzen, three miles from the centre of Hanover, August 18 to September 7, 1947. Among the exhibits will be plastic and rubber products.

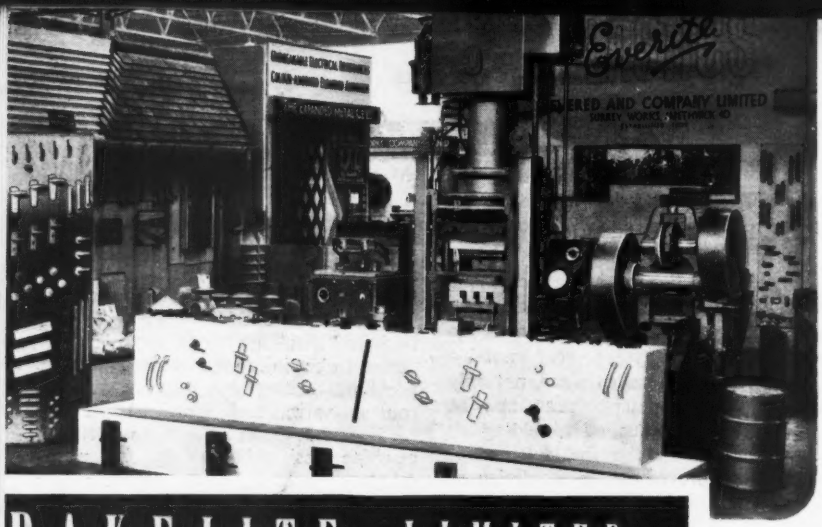
Plastics Machinery at the B.I.F.

THE fact that this year's British Industries Fair was the first to be held since 1939 was sufficient to promise, in the Engineering Section of the Fair at Castle Bromwich, a good display of machinery new to the plastics industry. During the intervening eight years very notable developments have taken place, not only with respect to materials, but also as regards the technique of moulding or otherwise making the finished article. Alongside improvements in the design of presses and allied machinery, there have come new processes such as the preheating of moulding powders, the welding of thermoplastics, and the postforming of laminates.

That the Engineering Section of the Fair promised a wealth of information new to industry generally was evident from the number of persons passing through the turnstiles; during the first five days the figure was 88,000, compared with 43,000 during the same period at the 1939 Fair. Exhibits of interest to the plastics industry ranged from the grinding of wood flour to a 100-ton transfer moulding press arranged for down-stroke injections, with automatic prefilling, a silver lever, piston-type main control valve, and sustained pressure (T. H. and J. Daniels, Ltd.); an extruding machine designed specially for p.v.c., cellulose acetate, and thermoplastic materials (Francis Shaw, Ltd.); a 10-ton dual upstroke unit, fabricated completely in mild steel, in which the conventional design of four columns was replaced by side plates fitted with machine guides, and incorporating push-button control (Finney Presses, Ltd.); and an injection machine designed for high-speed work, with settings possible for continuous automate cycle, single shot automatic cycle, or manual operation (E.M.B. Co., Ltd.).

In the new field of "radio-frequency"

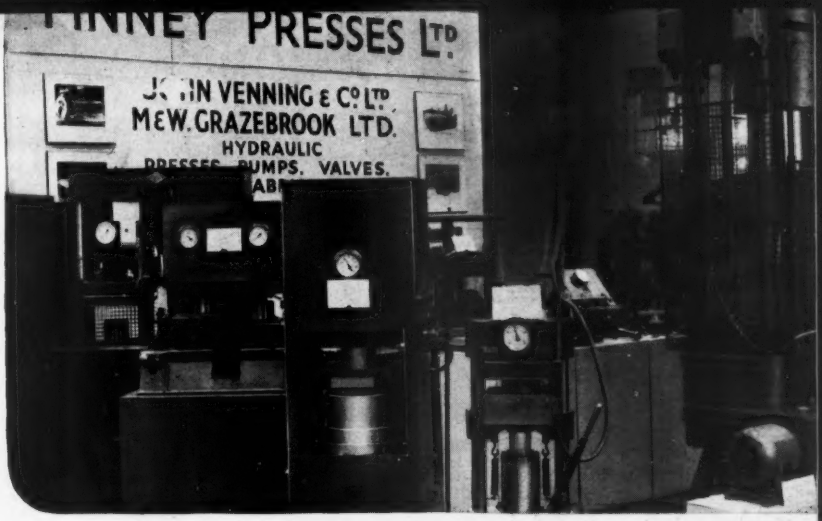
(Below) Joint exhibit of plastics moulding machinery by T. H. and J. Daniels Ltd., Alfred Herbert Ltd., and Francis Shaw and Co. Ltd.



(Above) Demonstration of manufacture of builders' plastic hardware by Evered and Co. Ltd.

(Left) Bakelite Ltd. show a range of mouldings and laminated materials.

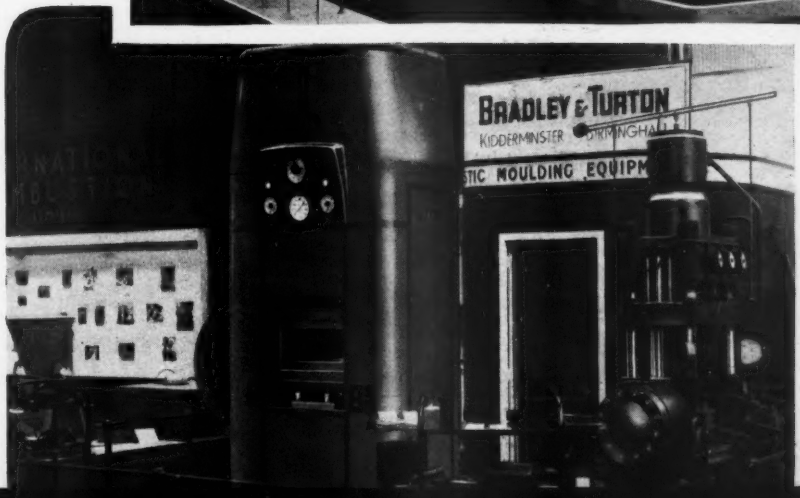
(Below) Glass fabric and other "Formapex" resin products featured by Ioco Ltd.



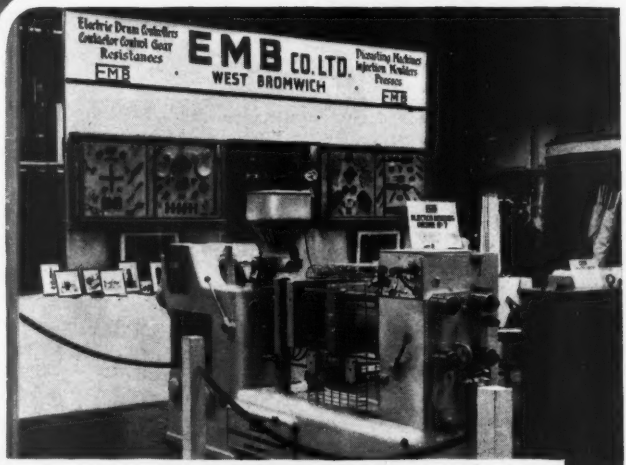
(Above) Machinery for the plastics industry, by Finney Presses Ltd.

(Right) Infra-red heating was one of the exhibits by General Electric Co., Ltd.

(Below) Bradley and Turton Ltd. make a feature of their 100-ton self-contained press.



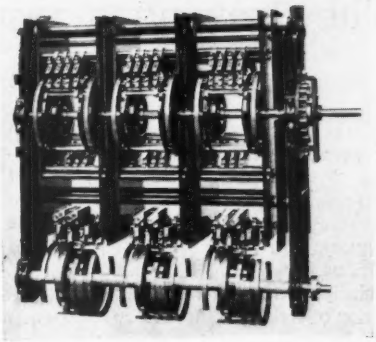
(Above) Rediffusion Ltd. show industrial dielectric and induction heating equipment.



(Right) Injection moulding machines by E.M.B. Co., Ltd., and range of goods in production by users.

(Below) Exhibit of injection moulding machines by T.M.A.

heating, there were three exhibitors: Rediffusion, Ltd., Delapena and Son, Ltd., and Radio Heaters. Among other applications, the Delton D.W. (Delapena) machine was shown as a preheater for p.v.c. granules prior to calendering. This process was developed by Delapena in conjunction with Erinoid, Ltd. By using radio-frequency preheating the hot-mixing and rolling processes, prior to calendering, can be eliminated, two operations actually being cut in the final production of the p.v.c. sheet. Under working conditions the material in suitable low heat-loss containers is placed between the electrodes of the preheater, and the heated powder or granules are then fed direct to the calender. Dielectric heating (likewise the related induction heating) is now well established as an industrial accessory, and as regards the plastics industry its value was also demonstrated as a method of hardening mould pins.



33 kV on-load tap changing switch for heavy electrical industry, incorporating Bakelite materials.

The stand of Bakelite, Ltd., gave a detailed story of the origins, properties and uses of Bakelite materials. Practical examples of uses in industry, ranging from giant switches to the insulating leaves of telephone selector banks, were shown. Typical of the reliance which heavy electrical industry places on Bakelite plastics in their various forms was the 33 kV on-load tap changing switch here illustrated. In this equipment, the vertical insulating panels are all laminated; the transverse rods are also insulated with Bakelite laminated tube, and the drum contacts are carried on mouldings produced from Bakelite material.

Exhibit of "Ferobestos" technical plastics for aircraft, engineering, electrical and other industries, by Ferodo Ltd.

The Brewing Industry Looks at Plastics

By John D. Glenn

THE brewing industry has shown a keen interest in plastics for the following reasons: First, as a means of increasing the attractiveness of licensed premises. Secondly, for improving the hygienic qualities and usefulness of various installations in licensed premises. Thirdly, to reduce the metallic contamination of fermented liquors by installation of plastic equipment or metal equipment coated or lined with suitable corrosion-resistant plastics. Fourthly, as material for making containers of various kinds, including linings for metallic and wooden containers, coatings for packages and liners for closures.

Turning to the use of plastics for improving the amenities of the hotel or inn, laminated sheets are extensively employed for wall panelling. Both urea and phenolic laminates are utilized, the former for light-coloured and decorative wall, table, and bar coverings, and the latter for the dark-coloured panelling and veneers. Laminated sheets of hollow construction are available for partitions and provide a convenient means of modernizing old premises or carrying out extensive renovations.

Brewing companies who have installed laminated material, either for decorative purposes or constructional uses, appreciate its smart appearance, good wearing properties, ease of cleaning, and dimensional stability, but it is realized that the urea-resin base sheet scratches somewhat easier than the phenolic type. The employment of melamine resins and melamine modified ureas should, however, make possible an improvement in the surface hardness of the light-coloured laminates, and so increase their general usefulness in service.

It is likely that increasing use will be made of metallized plastics for decorative purposes. Many striking effects can be achieved by use of mirror plastics for interior appointments in hotel and licensed premises. During the next few years extensive use is likely to be made of mirror-faced acrylics in sheet form and shaped to simple curvatures. This type of material is light in weight and non-shattering, and possesses excellent reflective properties.

Because plastics have a low moisture absorption, are unaffected by many common chemicals, and possess a smooth and easily cleaned surface, they offer obvious advantages when shaped into sinks and fitments in licensed premises. "Perspex" sheet is particularly suitable for this purpose as it is available in opal as well as various colours, is light in weight, reasonably robust and lends itself very well to the shaping of large units. Although "Perspex" is generally considered to scratch easily, its surface hardness actually is not inferior to aluminium. Transparent "Perspex" shows scratches more readily than does metal, because the scratches are viewed by reflected as well as transmitted light, whereas scratches on a metal, such as aluminium, are seen only by reflected light. Opaque "Perspex" does not show up scratches so noticeably unless the marks are very deep, and the opaque material thus retains its pleasing appearance throughout the life of the shaped or fabricated article.

Metallic contamination may cause darkening of alcoholic liquors, and also adversely affect the flavour. Plastics, in the form of phenolic-base resin, however, have been used for some years for coating metal containers intended for the transport of wines and spirits. Preparations based on phenolic-type resin have been used successfully in America for the coating of large metal fermentation

(*Continued on page* 371.)

Synthetic Resin Bearings

By F. W. JONES,
B.Sc., M.I.Mech.E., A.M.Inst.C.E.

In a recent editorial ("Plastics," May, 1947, page 227) we referred briefly to the advantages which could be secured by using synthetic-resin bearings in substitution of bronze. In view of the importance of the data revealed, we reprint below the original paper, by kind permission of the Council of the Iron and Steel Institute. It is one of four papers on Roll-Neck Bearings, presented at a recent meeting of the Institute's Iron and Steel Engineers' Group (J. Iron Steel Inst., April, 1947). The author is associated with Guest Keen Baldwins Iron and Steel Co., Ltd.

WHEN the Cardiff works of Guest Keen Baldwins Iron and Steel Co., Ltd., were rebuilt during the years 1934 to 1936, it was intended to use bronze and white-metal bearings on the blooming and light-section mills and Morgoil oil-film bearings on the continuous billet mill. The technical literature at that time, however, made it quite clear that moulded synthetic bearings made of resinous compounds and fabric were already operating on light-section mills with success, the power consumption being less than that on mills equipped with bronze or white-metal bearings. Ball or roller bearings were not considered to be a feasible proposition on account of the great number of rolls involved, each one of which would have to be fitted permanently with its own set of bearings. Attention was therefore directed to synthetic-resin bearings, on account of the savings that were claimed could be made by their use.

The claims made for these bearings included the following:—

(a) Reduction in friction, with consequent saving in power.

(b) The wear on the bearings being less, the rolls maintained their gauge setting for a much longer period of time, giving a higher standard of finished product.

(c) Owing to the copious supply of cooling water on the bearings and the insulating properties of the bearings themselves, the roll necks are far less prone to fire cracks.

(d) Reduction in general maintenance costs, including consumable stores. (The reduction in grease alone was to the extent of ½ ton to as much as 1 ton per week on the blooming mill.)

(e) Cleanliness.

After exhaustive inquiries it was decided to equip the new 21-in. light-section mill with synthetic-resin bearings from the time of its installation; the success obtained on this mill was such that the management were encouraged to consider the adoption of this type of bearing on the 40-in. blooming mill.

The project was started in November, 1936. Communications and discussions took place with the bearing manufacturers, and drawings for the alterations necessary to the chocks, for the laying of water mains, and for the installation of filters to ensure an ample supply of cooling water, were made. The actual conversion itself took until September, 1937, when the mill started rolling on moulded synthetic-resin bearings. To the best of the author's knowledge, this was the first large reversing mill in the world to be fitted out with such bearings, and the success of the venture was doubted by many.

Arrangement of Chocks with Bronze and with Synthetic Resin Bearings

(a) Bronze Bearings

With bronze bearings the top-roll chock is fitted with a "carrier bearing," which is supported by bolts and springs from a crosshead on the main screw and moves in direct relation to the main portion of the chock. There is no other mechanical connection between the chock and the carrier. The bottom-roll chock is fitted with a keep to exclude foreign matter as much as possible. The brasses for both chocks were made with a flange to cater for the roll thrust.

The arrangement was very similar to an ordinary plummer block and brass, except that the back side of the brass in this case had a zigzag water channel cast in it. This channel passed from one end of the brass to the other, axial with the roll neck, then back again, repeating the process until the whole of the pressure area was utilized. Water was introduced into the face of the chock at one side; it then passed through the zigzag channel, finally passing out at the exit on the other side of the face.

Reliance was placed on the metal-to-metal joint between the machined face of the chock and the machined face of the brass to ensure that the water traversed the whole length of the channel.

It was found in practice that the zig-zag channel left a raised impression on the chock face under working pressures. This raised impression was a very great nuisance when fitting new brasses.

The grease for lubrication was introduced through drilled passage-ways in the brasses by means of a mechanical pump.

(b) Synthetic-resin Bearings

In order to utilize the sets of chocks originally supplied for bronze bearings, a slight modification was necessary. To compensate for the thinner moulded synthetic-resin bearing (1 in. instead of 2-3 ins.), a steel liner was machined and fitted into the chock bore. This holds the moulded lining, which is prevented from turning by two keep plates fixed axially with the roll neck. Immediately under the keep plates in the case of the top roll (or over them in the case of the bottom roll) the water-spray pipes were introduced from a new distribution system. As this spray water is the only means of lubrication and cooling, the original grease and water piping was redundant. Owing to difficulties in moulding, the bearing liners and the bearing thrust collars have to be in separate pieces.

The scale guard for the bottom neck on the drive or first-pass side is now made by having a moulded sealing ring which is bolted to the chock keep and presses against the thrust-collar face of the roll This sealing ring is then covered by greasy packing, and the whole assembly is covered by a neatly fitting curved plate, which is also attached to the bottom-chock keep.

As was to be expected in an innovation of this kind, a series of troubles occurred, but these were gradually overcome and the lessons learned.

First, it is absolutely essential to have a copious supply of clean or, if necessary, filtered water at such a pressure that the water film at the intake side of the roll neck is sustained. This water also acts in a large measure as a preventive to ingress of grit and foreign matter to the rubbing surfaces by washing it away. A pressure of 25-30 lb./sq. in. has been found to be quite satisfactory.

Secondly, it was found that a slight deposit of rust on the roll necks (such as would form in, say, four hours and over with the rolls at rest and the water turned off) would be sufficient to cause abrasion of the fabric bearings. It was also found that the surface in contact with the bearing rusted quicker than that part of the roll-neck surface exposed to the atmosphere.

The elimination of these films of rust was a problem on which a series of experiments was carried out. It was found that, for short delays in the rolling programme (such as heat shortages and the like), it is better that the rolls be kept revolving, with the water supply running normally. For a delay of a few hours, when it would be expensive to keep the rolls running, coating the roll necks with thick lubricating oil just before they came to rest and with the water turned off was tried. This gave a certain amount of protection, but was not a guaranteed preventive against a rust film.

It was, and still is, the mill greaser's responsibility to see that no rust films form on the roll necks.

During the war, and as a result of research into the fields of de-watering, rust prevention, and the cleaning of machines which had been submerged owing to enemy action, a new oil was evolved. As our problem was well

known to the people carrying out this research, we were able to obtain some of this oil. The results were highly successful, and the problem of rust-film prevention now appears to have been solved.

For storage purposes the roll necks are now treated with this same oil, which preserves them in the open air for periods of up to six months. It should be mentioned here that in the early days, when rolls in storage had their necks dried, cleaned, and treated with a protective covering, a very fine pitting was prone to take place. This pitting could be removed successfully only by grinding the roll necks. As this was a laborious process, polishing with emery cloth was tried, but the results were not altogether a success and the method by no means answered as an alternative to grinding. It will be readily appreciated that these pit marks had a very bad effect on the fabric bearings, causing extremely rapid wear.

Thirdly, the destruction of the bottom roll bearings owing to scale getting on to the rubbing surfaces caused some trouble, but the arrangement previously described has improved matters, although the scale guards must receive constant attention and must be kept up to the highest possible standard.

The bottom-roll bearing on the heavy or drive side is the one that suffers the greatest punishment. This is the side on which the ingots first enter the mill. A bearing in this position gives only about 100,000 tons of rolling life.

Contrary to expectations, the next bearing to suffer is the top light side. One would have expected the top heavy side, or even the bottom light side, to show more wear than the top light side, but this is not so in practice. The reason for this is doubtless owing to the fact that the finished bars pass out of the mill on the light side. This means that the light-side bearings are more heavily loaded than the heavy-side bearings for the final passes. Further, the bars being longer, the sustained runs are greater, and the water film must be of such intensity that it will keep the whole surface of the bearing wetted when entering from only one side.

In comparing the top bearing with the bottom bearing it will be noted that the water film on the former has to be carried into the bearing against gravity, whereas in the case of the latter it is with the aid of gravity.

Costs and Comparisons

As the light-section mill is engaged in rolling so many different sections and the bearings are used with many different rolls, it is extremely difficult to obtain reliable figures regarding the individual performance of any bearing. The following figures are based, therefore, on the results obtained in the blooming mill, where conditions are such that the performance of each bearing can be carefully noted and records made of the individual tonnage outputs.

All the bearings in the blooming mill are 1 in. thick when new and are worked until their thickness is not less than $\frac{1}{4}$ in. As far as is possible, all changes of bearings are made at the week-end.

(a) Conversion of Blooming Mill from Bronze to Synthetic Resin Bearings

As previously stated, the chocks of the blooming mill were the only major parts needing modification, although a new water-distribution system had to be provided, which accounted for a fairly substantial part of the total cost of conversion. The costs were made up as follows:

Modification to existing chocks and supply of all new parts, piping, filters, etc.	£460*
Supply of one set of synthetic-resin bearings, collars and seal rings	£240
Total	£700

The cost of a set of bronze bearings in 1937 was £325, hence we could expect to save £85 in the cost of the renewable or wearing parts. Actually, the cost of a complete set of synthetic-resin bearings to-day is £235, showing a decrease of £5, which is doubtless due to improved methods of manufacture.

From the bronze bearings we could

* Approximate figure.

Table 1.—Comparative Power Consumptions with Bronze and Moulded Synthetic Resin Bearings

Bronze Bearings				Moulded Synthetic Resin Bearings			
Week ending	Tons Rolled	Units Consumed	Units per Ton	Four Weeks ending	Tons Rolled	Units Consumed	Units per Ton
6/11/37	6,449	139,420	21.6	26/1/46	41,419	757,860	18.3
13/11/37	6,771	146,150	21.6	23/2/46	41,354	709,080	17.1
20/11/37	8,365	165,630	19.8	23/3/46	47,407	785,250	16.5
27/11/37	6,869	152,940	22.3	20/4/46	46,919	777,250	16.5
4/12/37	8,036	158,130	19.7	18/5/46	45,982	774,410	16.8
11/12/47	7,935	163,390	20.6	15/6/46	41,002	696,560	16.9
—	—	—	—	13/7/46	46,891	788,240	16.8
Total ..	44,425	925,660	125.6	Total ..	310,974	5,288,650	118.9
Average ..	7,404	154,277	20.93	Average ..	44,425	755,521	17.0

Table 2.—Power Consumption on Mill Motor during 25th November, 1946

Number of Ingots Rolled	Ingot Weight		Total Ingot Weight		Passes per Ingot	Total Passes	Type of Section Rolled	Size of Section, in.	Power Consumption, units	Power Consumption, units/ton of product
	tons	cwts	tons	cwts.						
28	3	15	105	0	16	448	Sheet bar	12 × 2	1,700	16.2
15	3	18	58	10	19	285	Blooms	5 × 5	1,000	17.1
13	3	18	50	14	19	247	Blooms	5 × 5	900	17.7
23	3	18	89	14	19	437	Blooms	5 × 5	1,500	16.7
23	3	18	89	14	19	437	Blooms	5 × 5	1,500	16.7
27	3	18	105	6	19	513	Blooms	5 × 5	1,700	16.1
15	3	18	58	10	21	315	Blooms	5 × 6	1,200	14.6
6	3	18	23	8	19	114	Blooms	5 × 5		
16	3	18	62	8	19	304	Blooms	5 × 5	1,500	14.3
12	3	11	42	12	21	252	Blooms	5 × 6		

expect an individual bearing life of anything up to 11 months, working on a two-shift basis, whereas from synthetic-resin bearings we have obtained an individual bearing life of up to 30 months, working on a three-shift basis.

From figures to be given later it will be seen that a saving of up to 19 per cent. in power consumption can be obtained by the use of synthetic-resin bearings.

(b) Maintenance

With regard to maintenance, it has been the practice to change bearings and collars as far as possible at week-ends, when rolls were being changed; failures of bearings have, however, occasionally made it necessary to change them during the working part of the week. To do this occupies approximately 1 hour for a light-side synthetic-resin bearing and 1½ hours for a heavy-side synthetic-resin bearing, and the work involved occupies two fitters, two helpers, and one slinger, a total of five men.

In order to compare this with the work involved in changing bronze bearings, it can be said that the same number of men would require 5 hours for a light-side bearing and a somewhat longer period for a heavy-side bearing.

(c) Lubrication

To lubricate the bronze bearings it was necessary to feed into the mechanical grease pumps ½-1 ton of grease per week, at a cost of £33 per ton pre-war, or at to-day's price, £48 per ton. This would be 50 per cent. more in the case of the present three-shift operation. The whole of this cost is saved by the use of fabric bearings, but there is a charge for protective oil which amounts to approximately £1 per week.

(d) Water Supply

The water supply to the bearings is filtered through a twin strainer having a straining mesh of $\frac{1}{16}$ in. diameter holes, and is drawn from a near-by dock; the

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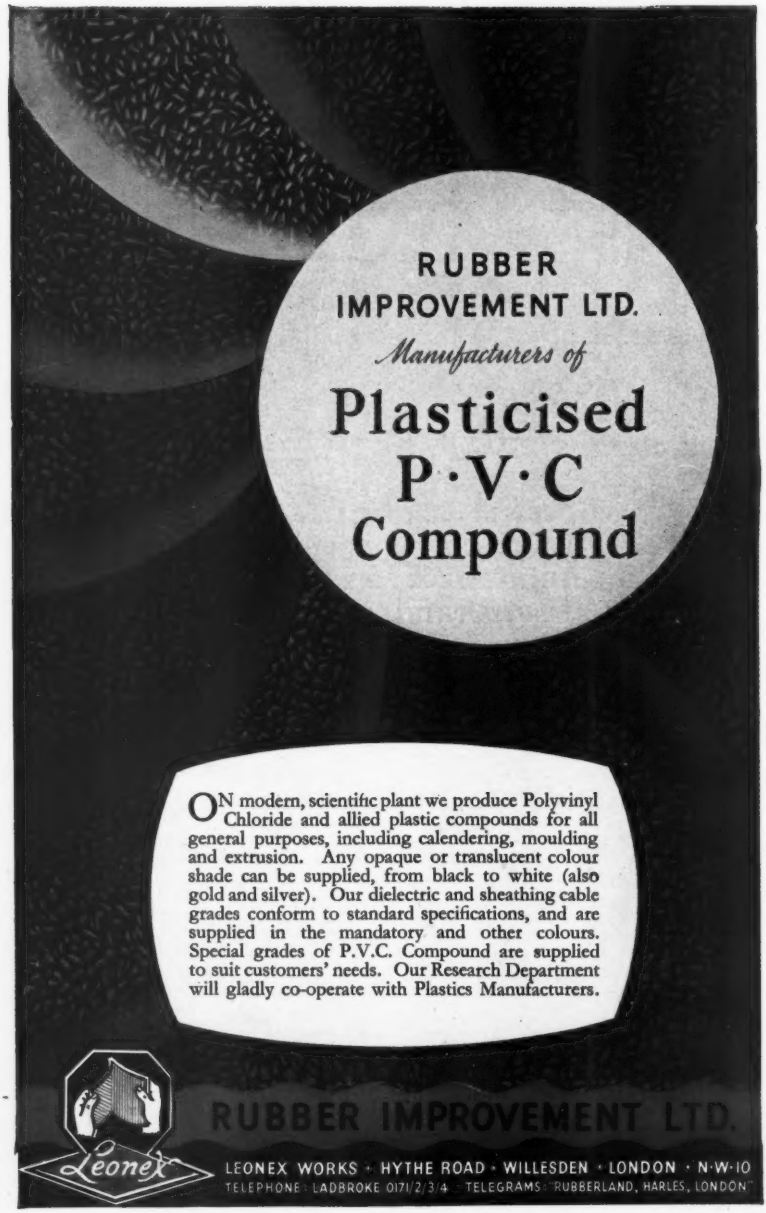
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water therefore contains a certain amount of foreign matter, and, although the dock is fed by a fresh-water feeder, the operation of the locks to allow ships to pass in and out of the dock permits a certain amount of contamination by tidal water. This contamination varies very much with the volume of shipping and has increased during the war. In general, the water is of the type which any industrial concern would use for cooling purposes in great volume.

The quantity of water used for roll cooling is approximately 200 gal./min.; this figure includes that used for roll-barrel and neck sprays. No separate measurements have been made to determine the exact quantity used on the roll bearings only. As all the water used is returned to the dock, and as the separation of bearing-cooling water appears to be an impracticable proposition, the question of using soluble oil and recirculating has so far been ruled out.

The continuity of the water supply is absolutely essential, because the bearings would burn out should it fail for even a matter of seconds. To ensure that the mill is not worked with the water supply below normal, two pressure-gauges have been fitted up on a panel immediately in front of the mill driver. One gauge shows the pressure of the water going to the heavy-side bearings and the other the pressure of water going to the light-side bearings. The connections for these gauges are made as near to the mill as possible.

Power Consumption

Typical figures for power consumption at the Cardiff works are given in Tables 1 and 2. From Table 1, which shows the power consumption when using bronze and when using synthetic-resin bearings, it will be seen that a power saving of 19 per cent. was achieved by the use of synthetic-resin bearings. Typical power consumption data for the 6,650 h.p., zero to 150 r.p.m. mill motor are given in Table 2. The ingot size is 21½ ins. by 21½ ins., tapering to 19½ ins. by 19½ ins., and the approximate length is 6 ft.

THE BREWING INDUSTRY LOOKS AT PLASTICS

(*Continued from page* 366.)

vessels in breweries and distilleries. These coated vessels appear to have given complete satisfaction under strenuous service conditions.

Polythene, the most inert plastic, is an obvious choice for lining metal containers by use of flow-casting technique. Unfortunately, there are no satisfactory adhesives for polythene; it cannot be made to adhere to metal surfaces. Against the use of polythene for liquor containers, there is also the fact that the material is relatively expensive, and the manufacture of large containers is at present difficult and somewhat uncertain, yet probably more important is the fact that this material is in very short supply.

Faced with a shortage of bottles, attention might be given to the use of containers made of polythene-coated paper or fabric. The thickness of the coating need only be extremely thin to give a high water resistance and to endow the base with considerable toughness. The polythene can be applied to the base by dipping, doctor knife or spraying, and the technique in a continuous process is fairly simple.

Another interesting, though minor, application is the use of polythene for the liners of moulded closures. These liners are capable of giving a high degree of protection, and are greatly preferable to the use of composition or cork liners. Incidentally, moulded closures are finding a growing use in connection with fermented liquors in this country, as well as in the United States.

Polythene extruded tubing can be used for conveying cold liquors; this tubing enjoys a high chemical resistance and possesses a useful degree of elasticity. For cold water plumbing, it offers the advantage that burst pipes cannot occur as a result of freezing.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office

FIAT Final Report No. 67.—This is a report of investigations in the synthetic industry in Germany which were undertaken to reveal new commercial techniques in the plastification, lamination and application of thermoplastics and thermosetting resins, as well as the specialized chemical developments and production of synthetic materials. There are sections covering 27 separate concerns, each of which concludes with a note of recommendations. The final conclusion drawn is to the effect that there have been some improvements and developments, in particular by I.G. Farbenindustrie, but the industry generally was one step behind that of synthetics and plastics in America. From information gained at the Research Institute of the I.G. in Weinheim, it appeared that no machine tools were made of plastics, excepting hammers, which are produced from polyamides. Regarding laminations made with thermoplastic resins such as Igelit (polyvinyl chloride), Igamit (polyamide I.G.), polystyrol in solution, synthetic resin emulsions, and Desmosite or Desmodure, average pressures of 100-200 kg./sq. cm. and temperatures from 100 to 180 degrees C., for 1 to 5 mins., were employed. The application of the " new adhesives," Desmosite and Desmodure, is based on the chemical reaction properties of di-isocyanate, examples being tolyene di-isocyanate and hexamethylene di-isocyanate. These di-isocyanates are combined with thermoplastic resins, but to obtain good commercial properties it is necessary to use combined thermoplastics, i.e., 3 parts adipic acid, $2R(COOH)_2$ and 4 parts hexantriol, $4R(OH)_3$, giving Desmophene 900, which, reacted with Desmosite T (tolyene di-isocyanate) at 120 degrees C., produces laminations of unusual strength, as in the case of steel sheet for transformers and electric generators. New " stiffening adhesives " for fabrics with plastic emulsions include polyacrylic acid esters, i.e., acry-acid methylethyl-, butyl-, ester or polyvinyl acetate. New plasticizers for the thermoplastic derivatives of cellulose, such as acetate, include the tetrahydrofurfuryl ester of oxalic acid, the isobutyl ester of the condensation product from caprolactam and propionic acid, and the acetate of oxaethyl-p-chlorphenol, but no comparison seems to have been made with the better-known phthalate plasticizers.

FIAT Final Report No. 202.—Manufacture of plywood and related products in Western Germany is the subject of this report, which covers approximately 50 per cent. of the plywood industry throughout the country. Two plants made metal-faced plywood consisting of aluminium 1 mm. thick on each side of a three-ply core 3 mm. thick. In process of development was a glue of the " Polystal " type (polyisocyanate resin), which is likely to be of considerable interest if preliminary tests are substantiated, as it is in neutral solution, has high resistance to water, and cures or sets at room temperature. Apart from VF and PF glues employed generally throughout the plywood industry, melamine resins were used to a very limited extent. Restricted use was due to the high cost of the straight resin. In order to reduce the cost, very large proportions of potato starch were incorporated. Glues of the " Polystal " (polyisocyanate) type were the greatest development in the field of resin adhesives, the polyisocyanates being used in ethyl acetate solution, with urea as the hardener or catalyst. The reputed properties of setting at temperatures as low as 0 degree C. in a comparatively short time, of being neutral to chemical reaction, and of possessing a great degree of toughness, are emphasized as highly desirable. The press time at temperatures as low as 0 degree C. is 6 to 8 hours. When cured, the toughness exceeds that

(Continued on page 394.)

Cellulose Acetate Plastics

II.—Chemical and Theoretical Considerations

By
Vivian Stannett

CELLULOSIC plastics are very different from other thermoplastics in that they are based on derivatives of a naturally occurring high polymer, "cellulose." The concern of the chemist in this field is to modify the structure of the cellulose molecule, without causing any excessive degradation. In other words, he is concerned with preventing the depolymerization of his material, and not with bringing about its polymerization. This means that his chemical approach is somewhat different.

The elucidation of the chemical structure of cellulose has occupied the attention of a large number of chemists for more than 100 years, and a great deal is now known of its structure and mode of behaviour. The generally accepted picture of a cellulose fibre is that it consists of a mass of long-chain molecules, lying in a part ordered, part disordered, fashion. The structure of the long chains themselves has been fairly definitely established as large numbers of glucose anhydride units, linked together as open chains in the manner shown in Fig. 1. Some of the steps leading to these conclusions will be described later. It can be seen from Fig. 1 that each glucose residue in the cellulose chain possesses three free hydroxyl groups, and, by the action of suitable reagents, these can be substituted to any degree. Cellulose acetate is the product resulting from the reaction of these hydroxyl groups with acetic anhydride, and their resultant replacement by acetate groups, as shown in Fig. 2.

The length of the molecular chains, which is, of course, directly proportional to the molecular weight, varies within each sample. That is to say, any given specimen of cellulose contains a large number of chains of widely varying lengths. The estimated chain length is therefore only an average value. These average values vary from sample to sample, according to the origin and treatment of the cellulose. Some typical figures are given in Table 1. The molecular weight of cellulose and its derivatives can be determined by most of the methods normally used for high polymers. The viscosity of dilute solutions, although not exactly proportional to chain lengths, is normally used for most practical purposes of comparison.

The cellulose acetate molecule can, therefore, be modified in two respects, namely, the degree of substitution of the hydroxyl groups, and the length of the molecular chain. In the mass, two further modifications are possible; these are (1) the polymolecularity, that is, the extent of distributions of chain lengths, and (2) the degree of orientation of alignment of the molecules. The bulk effect of some of these variants on the chemical, mechanical and other properties of the cellulose acetate will be dealt with in some detail in subsequent sections of this series. In the meantime, it may be interesting to consider one or two theoretical points relating to this variation of behaviour.

Native cellulose, particularly in the form of cotton and similar fibres, has an extraordinarily high-tensile strength. The

Table 1.—Molecular Weight of Cellulose (Ultracentrifuge methods) (Kraemer[2])

Type	Molecular weight (weight average)	Number of glucose anhydride units
Native cellulose ..	570,000	3,500
Purified cotton linters	150,000–500,000	1,000–3,000
Wood pulps	90,000–150,000	600–1,000

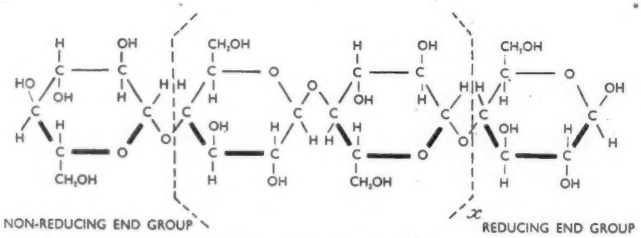


Fig. 1.—Structure of cellulose.

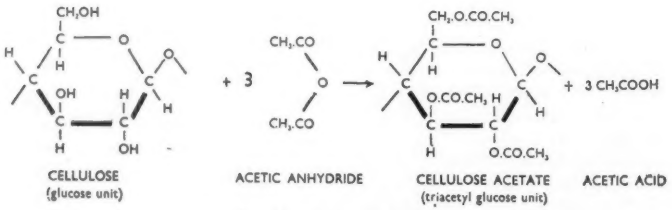


Fig. 2.—Acetylation of cellulose.

origin of this tensile strength is thought to lie in the powerful forces of cohesion between the molecular chains. Rupture of the fibre can obviously take place in two ways, either by fracture of the main valency links, that is, of the molecular chains themselves, or by the chains slipping past each other, causing thinning and ultimately breaking. The two processes have been shown pictorially by Meyer[1], as in Fig. 3. In practice, it is usually found that, up to a point, increase in chain length leads to an increase in tensile strength, and then there is a falling-off of this effect. It is usually considered that, at the point where this happens, the chains are so long that the forces of cohesion between them are greater than those required to break the main valency links, and, consequently, the latter process predominates. The origin of the forces between adjacent chains of cellulose is now thought to be due to "hydrogen bonding" between the hydroxyl groups, and a brief explanation of this term may not be out of place here.

When two or more electronic structures can be formulated for a molecule, without changing the position of the atoms and with similar energy content in each form, then the actual electronic state of the molecule has a lower energy content, i.e., is more stable, the actual state being roughly intermediate between the extreme forms. This phenomenon is known as resonance or mesomerism; it can be detected by the increased stability of the molecule, which is shown by the increased heat of formation, or heat of dissociation. Hydrogen bonding is a special form of resonance, where a hydrogen atom acts as link between two electronegative atoms, such as oxygen.

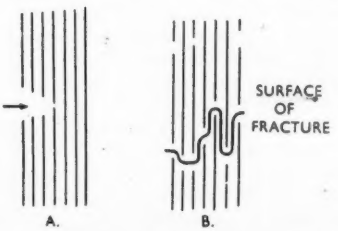
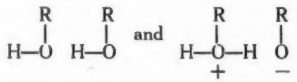


Fig. 3.—Two types of fracture. (Meyer[1])
A. Rupture of the chains.
B. Slipping of the chains.

In one form of this phenomenon, the hydrogen atom can pass from one molecule to another, giving alternative structures of similar energy content, and this is found to occur particularly with substances containing hydroxyl groups. An example can be given of two molecules of an alcohol R—OH, thus:—



The two molecules are held together by resonant energy. Possibly the sort of thing which takes place with cellulose hydrogen bonding is resonance between the two structures, as shown in Fig. 4.

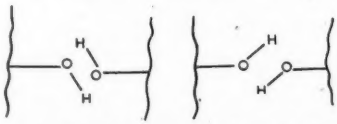


Fig. 4.—Possible mesomeric forms leading to hydrogen bonding. (Wavy lines represent remainder of cellulose molecule.)

It should also be mentioned that the degree of alignment of the chains, that is, the degree of orientation, also influences tensile strength, as the closer the packing the more the attractive forces are given full play. The forces holding the chains together are also sufficiently strong to restrict deformation by rise in temperature and consequently lead to a lack of thermoplasticity. Using similar arguments to those employed when discussing tensile strength, it can be shown that other mechanical properties, including elongation, flexibility and impact strength, are also dependent on the amount of slipping which takes place between the molecular chains when stretched.

To increase thermoplasticity and improve the elastic properties, the chains must be separated in order to lower the forces of cohesion and consequently increase the intermolecular slip. This can be brought about by two methods; either by introducing substances which have greater attraction for the hydroxyl groups and thus penetrate between and push aside the chains, or by replacing all or some of the hydroxyl groups with bulkier groups, such as acetate, the latter method also reducing the possibility of hydrogen bonding. The former process is really the same as plasticizing.

Separation, if carried out to extremes, leads eventually to solution, and the difference between solution and this type of plasticization is really only one of degree. Similarly, the difference between a solvent and this type of plasticizer is usually merely a question of volatility. This is to say, a volatile solvent causes temporary separation of the chains, whereas an involatile one remains a permanent part of the system. It should be remembered that volatility is a function of molecular size among other things, and that the above remarks only apply to solvent plasticizers. Because of the strong attraction between the molecular chains in cellulose and the close packing possible, very few solvents have been found, and none of these are at all permanent. This fact explains why cellulose itself is not available as a plastic, whereas its derivatives are.

Effect of Substitution

The second method for bringing about the necessary separation of the chains is by replacing the hydroxyl groups by other groups. This can be done by the formation of ethers, such as ethyl cellulose, or of esters, such as cellulose acetate. It would be expected that the larger the substituent group introduced, the greater the anticipated effects, that is, lowering of the softening points, increase in solubility, and elongation, and so on. This is actually the case, as is very well shown in Fig. 5. The rise in the curve which occurs, after about the C_9 ester, is considered to be due to the effect of increasing molecular weight. The extent or degree of substitution also brings about variation of these properties.

In general, elongation, flexibility and similar properties increase with increasing degree of substitution to a maximum, and then decrease somewhat. This decrease is thought to be because, with a

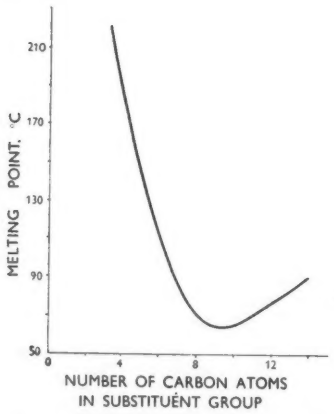


Fig. 5.—Effect of size of substituent group on melting point of cellulose tri-esters. (Sheppard and Newsome[5].)

completely substituted molecule, close packing of the chains is again possible, whereas, with partial substitution, the surfaces of the chains are more "ragged," with consequent increase in mobility and slip. Also the poorer packing resulting from the uneven surfaces gives improved solubility characteristics. A similar effect can be brought about by substituting with two different sized groups, such as is the case of mixed esters, an example being cellulose acetate butyrate.

It should be noted that the separation of the molecular chains, although desirable because of its effect on such properties as softening point and flexibility, has an adverse effect on other important mechanical properties, such as tensile strength and rigidity, and the art of manufacture is to strike a balance between these many factors to give a product of maximum value. The effect of increasing the size of the substituent groups on the tensile strength of cellulose ester films is shown in Fig. 6, and illustrates this point.

Polymolecularity

Mention has already been made of the fact that a sample of cellulose consists of molecular chains of widely different lengths, and the same is true, of course, of its derivatives. A typical distribution curve of chain lengths in a commercial sample of cellulose acetate is shown in Fig. 7. The presence of a large number of short chains has been found to adversely affect the tensile strength and other mechanical properties, presumably due to the "pulling out" of the small chains under stress. A good illustration of this effect is given by Spurlin in the graph shown in Fig. 8. Here it is clearly seen that the samples which are most uniform in molecularity have a greater folding strength than comparable samples of greater polymolecularity.

Orientation

If a poorly orientated fibre is loaded only those chains lying parallel to the axis take the load. If the degree of alignment that is the orientation is then increased, it is natural to expect an increase in tensile strength, and this is

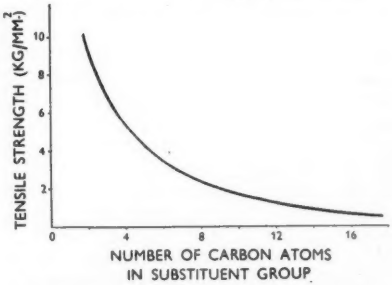


Fig. 6.—Effect of size of substituent group on tensile strength of cellulose tri-ester films. (Sheppard and Newsome[5].)

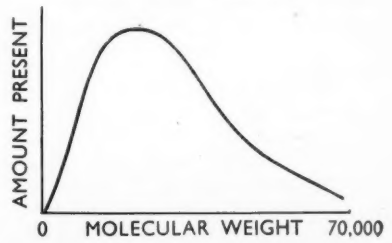


Fig. 7.—Polymolecularity of commercial cellulose acetate : typical curve.

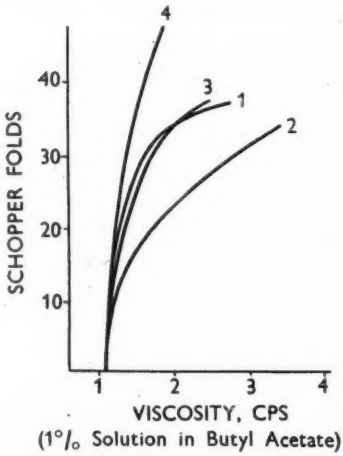


Fig. 8. — Effect of polymolecularity on folding strength as shown by viscosity of cellulose nitrate solutions. (Spurlin[8].)
1. Normal NC (unfractionated).
2. Blend 20—$\frac{1}{8}$ sec.
3. Blend 5—$\frac{1}{8}$ sec.
4. Blend $\frac{1}{4}$—$\frac{1}{8}$ sec. (fractionated).

actually the case, as the figures given in Table 2 show. An increase can be brought about in the tensile strength of film also by orienting. By the same argument, it is seen that the increase in tenacity in one direction is accompanied by a decrease in another, and this fact is well shown by the figures obtained by Mark and given in Table 3. Similarly, the tearing strength in the two directions with and across the axis of orientation show a very marked difference. In practice, a compromise would have to be made in order to produce the maximum tenacity in the direction where it is most needed, although at the moment no special effort is normally made in the cellulose plastics industries to orient its sheet and film products.

There remains one further influence which has not so far been mentioned. This is the distribution of the substituent groups. For example, a molecule of cellulose acetate with an average of, say, two acetate groups per glucose residue, could have one end of the chain completely acetylated and the other end completely unsubstituted. This type of molecule will have different characteristics from an evenly acetylated type, owing to the opportunity for closer packing, etc., along the unsubstituted portion. Little work has been published on this topic, but it is obvious that properties such as solubility may be profoundly affected. The history of a cellulose derivative can never be completely known, and so the exact behaviour of a given sample cannot be precisely predicted or explained. Nevertheless, great practical help can be derived from a knowledge of the average constitution of a derivative. The subject of plasticizing has only been touched upon here, as it is intended to deal with this aspect in more detail later on in this series.

Structure of Cellulose

The structure of cellulose is given in Fig. 1, and it is proposed to outline some of the work leading to this conclusion. The combustion analysis of cellulose gives figures corresponding to the empirical formula $C_6H_{10}O_5$, and this directly suggests a hexose anhydride composition. This suggestion is confirmed

Table 2 (Mark[4]).—Influence of Orientation on Tenacity

	Tenacity, g. per denier
Viscose rayon, poorly oriented	1.7–1.9
Viscose rayon, moderately oriented ..	2.0–2.6
Viscose rayon, highly oriented	3.0–3.5
Viscose rayon, extremely oriented ..	Up to 5.8
Acetate rayon, poorly oriented	1.3–1.6
Acetate rayon, moderately oriented ..	1.8–2.3
Acetate rayon, highly oriented	3.5–4.0

Table 3 (Mark[4]).—Influence of Stretching of Film on its Tenacity in Different Directions

Angle between the direction of stretching and a given direction in the sheet	Tenacity before stretching kg. per mm.[2]	Tenacity after stretching kg. per mm.[2]
0°	11.6	26.5
30°	11.2	15.7
60°	11.4	10.2
90°	11.5	4.5
120°	11.9	9.3
150°	11.2	14.7
180°	11.1	25.9

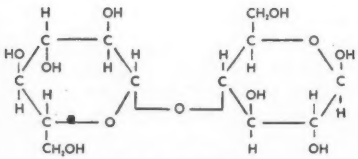


Fig. 9.—Cellobiose.

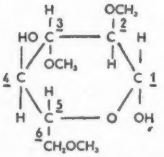


Fig. 10.—2.3.6.-Trimethyl glucose.

by the fact that the complete hydrolysis of cellulose gives a high yield of glucose, figures of up to 95 per cent. yield having been obtained. With incomplete hydrolysis under carefully controlled conditions, fragments containing two, three and more glucose units joined by primary valency links have been obtained, thus indicating that the glucose units are joined by primary valency linkages. The presence of three hydroxyl groups per glucose unit is shown by the fact that a triacetate and a trinitrate can be obtained by esterification, no higher esters having ever been prepared. So far, the evidence is straightforward, and the problem, in simplified form, presents itself as the determination of the position and type of linkages between the glucose units, the position of the free hydroxyl groups, the length of the molecular chain, and the configuration of the end groups.

One of the products of the controlled hydrolysis of cellulose is cellobiose (Fig. 9), containing two glucose residues per molecule. The structure of this compound has been definitely established as containing a beta-glucosidic linkage which indicates the type of linkage present in cellulose. The beta-glucosidic linkage is also indicated by X-ray measurements, rate of hydrolysis, and optical rotation measurements. The position of the free hydroxyl group has been shown by the work of Haworth; he completely methylated cellulose and then hydrolyzed. The resulting material showed a good yield of 2.3.6-trimethyl glucose (Fig. 10), thus giving the position of the hydroxyl groups as 2.3.6. Assuming the internal oxygen link is in the 5 position, as is the case with glucose itself, the units must be linked through the 1.4-positions.

In the products resulting from the complete hydrolysis of fully methylated cellulose, Haworth also identified and estimated a small but definite amount of 2.3.4.6-tetramethyl glucose. This indicated an open chain rather than a ring structure, and showed that at least one end group contained a free hydroxyl group, and that this was in the 4 position. The structure of the second end group has not been conclusively proved, but it follows logically from a consideration of the regularly repeating unit head-to-tail structure and from the fact that all cellulose shows some reducing power which is increased progressively with degradation. There is no doubt that other types of group exist here, especially in treated cellulose, owing to the ease with which the hemiacetal group can be oxidized or otherwise modified.

The regularity of the repeating units of the cellulose molecule has been demonstrated by X-ray measurements of the crystalline portions. The length of the molecular chains can be calculated from the amount of tetramethyl glucose present on hydrolysis of the methylated sample or by other methods of molecular weight determination.

The account given above has been necessarily brief and is intended to give an indication only of the methods used.

(To be continued)

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(1) *Meyer, "High Polymers" (Interscience), Vol.* 4, *p.* 330. (2) *Kraemer, Ind. Eng. Chem.*, 1938, **30**, 1200. (3) *Spurlin, ibid.*, 538. (4) *Mark, "High Polymers" (Interscience), Vol.* 5, *p.* 1010. (5) *Sheppard and Newsome, J. Phys. Chem.*, 1935, **39**, 143. *(General) "Chemistry of Large Molecules." (Interscience,* 1943.*) Adamson, I.P.I. Trans.*, 1947, 11-21. *Mark, Chem. Reviews*, 1940, 169-186. *Meyer, "High Polymers" (Interscience), Vol.*4. *Ott, "High Polymers" (Interscience), Vol.* 5.

. . . . . the mark which symbolises the production of plastic mouldings in very large quantities.

In spite of shortages the Walthamstow works of British Moulded Plastics Ltd., one of the National Plastics companies, delivers many thousand mouldings each week to the radio industry, the motor car industry, the British Post Office and to many important firms making accessories for the housing programme.

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Patent **DIAPHRAGMIC**
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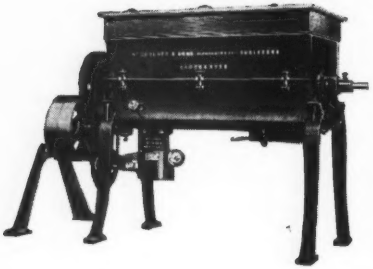

HAVE you a problem in which the uniform feeding of material would be an advantage?

The Patent Gardner Diaphragmic Feeder has been redesigned to reduce irregularities in the feeding of material to a minimum.

The material is fed in bulk in a "U" shaped Hopper in which a slowly revolving agitator keeps the material in a free-running state.

A control slide allows the material to enter the feeding chamber only as required to keep it full, and suitable agitators are fitted to prevent packing.

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Many hours' supply of material can be fed in the Hopper at one charge.

Machine is equally successful for adding small or large quantities to bulk.

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Send details of your requirements

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LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired.

Radio Frequency Heating

Sir,—I have read with interest Dr. Zade's remarks concerning the use of radio frequency heating (" Plastics," May, 1947, page 250), and despite the seemingly formidable list of technical references which he produced, it is still my opinion that the subject has received comparatively little attention in the technical Press, in the form of general, rather than highly technical, articles.

Concerning the second point made by Dr. Zade in connection with the roller electrodes, he is so obviously correct that no further comment is necessary. The main point of the suggestion was to minimize the flow of material when in its plastic state.

D. WARBURTON BROWN.

Cheltenham.

Bonding Cellulose Acetate

Sir,—We are using glacial acetic acid to bond cellulose-acetate mouldings together. Can you suggest an alternative?

London. L.C.C.

[EDITOR'S NOTE: Glacial acetic is not a pleasant material for workers to use. We suggest a mixture of polyvinyl acetate and ethyl acetate, which would provide what might be called " double action."]

Thermoplastic Sheet

Sir,—We have had an inquiry for " Cellon " sheeting (cellulose-acetate sheeting), together with a further inquiry for " Astralon " sheeting in black and white. We shall be glad if you can suggest manufacturers who are likely to be able to supply us with these materials; our inquiries, so far, have proved fruitless.

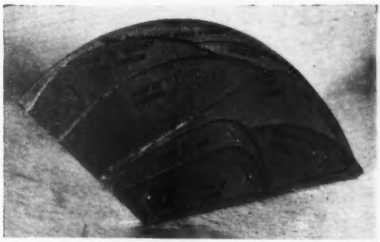
MODERN COMMODITIES, LTD.

49, Seymour Street, W.1.

[EDITOR'S NOTE: Cellon sheeting was the trade mark for the cellulose acetate made by Rheisnisch-Westfalische Sprengstoff A.-G., of Cologne. Astralon was a vinyl polymer similar to Mipolan, and made by Dynamit A.-G., of Troisdorf. For compounds similar to Astralon, application should be made to British Resin Products, Ltd., Abbey House, Baker Street, London, W.1.]

Building Instrument

Sir,—I would esteem it a favour if you could provide me with the name and address of any firm agreeable to manufacturing the enclosed article in plastic. The shape is somewhat awkward, but I think a mould could be made suitable for the purpose. It is part of an instrument



used in the building trade for roofing. In previous models this part has been made in fibre board, but this has not proved entirely satisfactory, due to poor wearing properties. An initial order for 5,000 could be given. WM. LANHAM.

141, Englishcombe Lane,
Bath.

[EDITOR'S NOTE: While this is obviously a simple production if moulded, the thinnest portion is somewhat under 1/32 in., so that it might be necessary to make the whole rather thicker. Perhaps it would be best to construct the instrument out of cemented cellulose acetate cuttings or laminated phenolic sheetings suitably bonded together. Perhaps vulcanized fibre would prove quite suitable. Overall size is 6¼ inches.]

Plastics for Furniture

Sir,—We are much interested in using plastic in our production of prams. The

prams are now manufactured of veneer and are lacquered on the outside with synthetical lac; this is, of course, an expensive and circumstantial process. We understand that there are factories manufacturing plastic which can be glued to wood by means of a special type of solution, or which can either be sprayed in liquid condition or flame-sprayed in powder condition, making a hard and smooth surface when it is dried. We should highly appreciate being put in touch with suppliers of the above-mentioned articles.

MASKINHUSET A/S.
P.O.B. 201.
Stavanger, Norway.

Silicones

Sir,—The General Electric Co. of America have developed some silicone oils and greases which, we understand, have proved very successful in resisting high temperatures and the action of ordinary solvents. We would be grateful if you could advise us of the makers of similar material in this country.

PLATERS AND STAMPERS, LTD.
Burnley.

[EDITOR'S NOTE: Albright and Wilson, Ltd., of Oldbury, Worcestershire, are distributing agents in this country for most silicones.]

Plastic Seal

Sir,—We are desirous of finding a medium for sealing the lid of a domestic pressure cooker, and should be grateful if you could suggest some manufacturer to help us. The seal would be required to withstand saturated steam at 15 lb. pressure and give satisfactory results over a long period. We enclose a piece of plastic-covered cable (origin unknown), which has given quite good results on trials.

J. SAMUEL WHITE AND CO., LTD.
Somerton Works,
Cowes, Isle of Wight.

[EDITOR'S NOTE: The sample appears to be polyvinyl chloride covering a copper conductor. As the temperature would not be appreciably higher than 100 degrees C., this extrusion might prove the solution, although we should suggest extruding over as many metal wires as possible to increase conduction of heat away from the plastic.]

Bathroom Fittings

Sir,—We have received a substantial inquiry from Saudi Arabia for the export to that country of plastic bathroom fittings, such as towel racks, soap dishes, tooth brush holders, etc.; also door fittings, including handles, door plates, etc. We shall be glad to contact sources of supply.

A. ABDULLAH AND SONS, LTD.
2-3, Helmet Court,
Wormwood Street, E.C.2.

Book Binding

Sir,—We have been requested by our representative in Rio de Janeiro to submit samples and quotation for plastic or "Perspex" book binding rings. If you could make any suggestions as to a likely source of supply, we would esteem it a favour.

BARNET BROTHERS (MERCHANTS), LTD.
62, Hunters Road,
Birmingham, 19.

[EDITOR'S NOTE: The effect can be accomplished in the form given, namely, as alternating clips, or as a continuous spiral. We believe BX Plastics, Ltd., Hale End, London, produce both types.]

Printing on P.V.C. Sheet

Sir,—We are interested in the printing of p.v.c. sheet, or similar, by the silk screen process, and would be indebted for any information published or otherwise available on the subject.

What we are mainly in need of is a suitable medium to mix with our colour to ensure good adhesion to the sheeting, but one that will stretch with the sheet and not crack nor flake off. If you know of a firm marketing such medium or colours suitable for printing with our process we would be glad to have this information, and will be indebted to you for any further help you may be able to give us.

Castlefields, DISPLAD, LTD.
Chester Road, Manchester, 15.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

COUNCIL OF INDUSTRIAL DESIGN. The Board of Trade announce that the following have been appointed additional members of the Council of Industrial Design:—Mr. John Anderson, managing director, James Templeton and Co., Ltd.; Mr. A. Leigh Ashton, director and secretary of Victoria and Albert Museum, Mr. G. W. Lacey, director and general sales manager, British Aluminium Co., Ltd.; Major F. J. Stratton, managing director, Upsons, Ltd. (Dolcis Shoe Co.); Dr. W. J. Warboys, chairman, Board of Plastics Division, Imperial Chemical Industries, Ltd. Sir Kenneth Clark and Mr. G. W. Odey resigned from membership of the Council earlier in the year.

TITANIUM PIGMENT MANUFACTURERS' Technical Committee has appointed Mr. S. G. Tinsley (British Titan Products Co., Ltd.) as chairman, with Mr. J. T. Richmond (National Titanium Pigments, Ltd.) as secretary. The address of the Committee is care of National Titanium Pigments, Ltd., Kingsway, Luton, Beds.

POLYSTYRENE MOULDING POWDERS.—Dow Chemical of Canada, Ltd., have appointed E. H. Cole and Co., Ltd., 2 Caxton Street, Westminster, S.W.1, as their agents in Great Britain for the supply of polystyrene moulding powders, including crystal and coloured material.

LIGNIN.—Howard Smith Paper Mills, Ltd., have appointed R. H. Cole and Co., Ltd., as their agents in Great Britain for the supply of lignin, which will be available chiefly in the form of a spirit soluble resin and as lignin impregnated paper.

BIRKBYS, LTD., of Liversedge, Yorkshire, have opened a new London Office at 79, Baker Street, W.1 (telephone: Welbeck 3746). The London Office will be in charge of Mr. C. R. Todd, who will be assisted by Mr. S. A. Perry. Mr. Todd will confine his activities more particularly to "Elo" products in moulded form, whilst Mr. Perry will look after "Elo" plastics in the form of moulding powders, resins, varnishes, cements, etc.

LEICESTER, LOVELL AND CO., LTD., of North Baddesley, Southampton, manufacturers of the "Casco" range of synthetic resin and casein glues, announce that Mr. H. A. Collinson, A.R.I.C., has been appointed a director of the company. Mr. Collinson will continue in his capacity as chief chemist and works manager.

FRANCIS SHAW AND CO., LTD., announce that their London Office address is now 20 Abbotswood Road, Streatham, London, S.W.16. Telephone (as previously): Streatham 0520.

A. C. WICKMAN, LTD, of Coventry, have acquired the radio heating equipment company, Diaplastics, Ltd., for whom they have hitherto acted as sole world agents. A new board of directors is to be formed by Mr. E. A. Hyde, Mr. A. H. Jarrad, the Hon C. M. Maclaren, and Mr. G. C. Trowbridge.

THE VISCO ENGINEERING CO., LTD. In accordance with their policy of associating experienced members of the staff with the management of the company, the Visco Engineering Co., Ltd., Croydon, have elected Fred C. Smith (works manager), L. C. Ellis, M.I.H.V.E. (chief engineer), and E. H. Hilton (secretary) to the board of directors. Each of the new directors has had nearly 20 years' service with the company.

NICORIA, LTD., 205, Endsleigh Court, Upper Woburn Place, London, W.C.1, have a new line of business in offering Stedall's "Shipton" injection moulding machines, special moulds for polythene, and supplies of polythene moulding powders.

THE DISTILLERS CO., LTD., announce that they have authorized expenditure of about £2,000,000 with the view to expanding the output at the works at Salt End, Hull, belonging to their subsidiary, British Industrial Solvents, Ltd. The products involved cover solvents, plasticizers, acetic acid and acetic anhydride. This expansion is necessitated by the growth of consumption of these products in the plastics, rayon, fine chemical and dyestuffs industries.

ACTICARBON, LTD., 175, Piccadilly, London, W.1, announce that the name of the company has been changed to The British Ceca Company, Ltd.; the address remains the same. The change has been made to bring the name in the British Empire into line with the world-wide organization of CECA (Carbonisation et Charbons Actifs) of Paris, whose technical processes are used.

SURPLUS WAR EQUIPMENT.—George Cohen, Sons and Co., Ltd., have signed a contract with the Ministry of Supply for the acquisition of the whole of the plant and equipment accumulated at the Main Collection Depot for War Surplus at Avant-Port, Brussels. The purchase includes a vast amount of unused engineering equipment and stores, notably electric generating sets, transformers, pumping equipment, etc. The plant will be available for export from Belgium. Items can be imported into Great Britain provided an import licence is obtained.

D. R. ALDRIDGE AND CO.—The partnership of D. R. Aldridge and A. W. Wigley, trading under the name of D. R. Aldridge and Co., ceased as from June 21, 1947. The business is being continued by A. W. Wigley at the same address, viz., 135, High Street, Bromley, Kent.

LACTIC CASEIN PRICES.—The Board of Trade announce that as from July 1, 1947, the selling prices of lactic casein distributed through the Lactic Casein Importers' Association, 23, St. Swithin's Lane, London, E.C.4, are reduced £15 a ton, the new prices being as follows:—

Mesh.	1 ton and over.	Under 1 ton.
90	£225	£230
60	£220	£225
30	£220	£225
soluble	£230	£235

For quantities of under one bag the price drops from 5s. 3d. a kilo. to 5s. All the above prices are net ex warehouse.

Personal Notes

MR. K. GOODWIN has resigned his position as chief draughtsman to Moulded Products, Ltd., of Tyburn, Birmingham, and has joined the board of directors of M.C.M. (Tools), Ltd., of 12, Denmark Street, Aston, Birmingham, 19, who specialize in the design and manufacture of plastic moulding tools and their accessories.

Major T. Knowles was invested with the C.B.E. by H.M. the King at Buckingham Palace on June 10. Major Knowles is a past chairman of the British Plastics Federation, and at present the head of the By-Products Branch, Ministry of Fuel and Power.

SIR ROBERT ROBINSON, F.R.S., Waynflete Professor of Chemistry in the University of Oxford and President of the Royal Society, has been awarded the 1947 Albert Medal of the Royal Society of Arts for "his outstanding contributions to the advancement of organic chemistry." During the past thirty years, Sir Robert has added greatly to our knowledge of the mechanism of organic reactions.

MR. R. B. HARLEY has returned from India, and is resuming his full-time duties with Thomas De La Rue and Co., Ltd. Mr. Harley will, however, act in a consulting capacity to British Moulded Plastics, Ltd.

SIR CLIFFORD PATERSON, F.R.S., has been elected chairman of the General Council of the British Standards Institution in succession to Sir William Larke.

DR. JOHN J. GREBE, director of the Physical Research Laboratory of the Dow Chemical Co., of Midland, Michigan, has received the 6th John Wesley Hyatt award given in America for outstanding achievement in the plastics industry during 1946.

New Productions from the Moulding Shops

Moulded Chessmen

Traditionally, chessmen have always been hand carved at varying degrees of cost—the material employed ranging from ivory to boxwood. With plastics as an alternative material, it was deemed possible to supply the need of a set of moulded chessmen to command really large sales at a popular price in the export and home markets. Hitherto, only one instance was on record where chessmen had been moulded. That was in Australia, a few years back, but due to relatively high cost, and to the fact that these particular pieces were moulded solid, there was no attempt at mass production. Turning to this problem more recently, the Chad Valley Co., Ltd., suggested hollow

mouldings, the hollowness being to the maximum extent possible in order to save material and also to shorten the curing time. The pawns did not present any great difficulty, but figure pieces were not too easy to design for high-speed production. This problem was submitted to Witton Moulded Insulation Works, and they in turn sought the collaboration of the Streetly Manufacturing Co., Ltd. In due course compression moulding was decided upon for the pawns, and a high-speed transfer mould layout for the figure pieces. Actual production was shared between the two companies mentioned. A notably high standard of accuracy was called for in the construction of the moulds, to avoid disfiguring flash.

Breather for Transformer

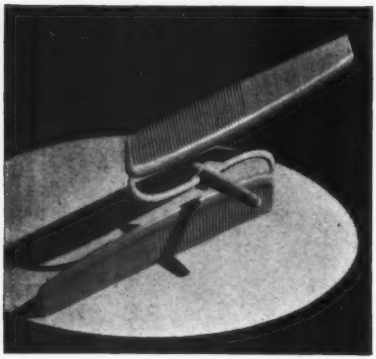
The latest Metrovick silica-gel transformer breather (Metropolitan-Vickers Electrical Co., Ltd.) is fitted with a transparent "Distrene" casing, which in accessibility and appearance is an improvement on

the old metal-cased type. Silica-gel attracts moisture, and therefore provides a suitable means of drying the air which is breathed into a transformer during cooling periods. The gel itself is not permanently affected by the moisture, but when a substantial amount of water has been collected it requires reactivation (by heating). In practice the crystals are treated with an anhydrous blue cobalt salt, the colour gradually changes to pink as water is absorbed, and when the colour change is complete it is indication that reactivation is necessary. In the new design the plastic casing allows the colour of the crystals to be inspected over the whole surface of the breather, whereas with a window in a metal casing the view is limited, thus making inspection less effective. The new breather, 8⅝ in. high, has the container

held to the die-cast top cap by a central bolt; a labyrinth oil seal at the bottom prevents contact between the gel and the atmosphere except when breathing is taking place.

Raw Material for Combs

The accompanying photograph shows no startlingly new production, for combs have been moulded by the injection process for many years. The raw material, however, is new in the sense that fair quantities are at last being imported. It is cellulose aceto-



butyrate, which has certain advantages over the "straight" acetate in that moulded objects made from it have greater toughness, greater water resistance, in addition to good dimensional stability. The combs shown are manufactured for customers by Capp Plastics, 1 Goding Street, London, S.E.11, who have a rare knowledge of injection moulding and consider cellulose aceto-butyrate to be an improved material for comb-making and many other jobs.

Handle for Electric Iron

A new electric iron, with numerous improvements on most existing types, is now in production at the factory of British Electric Motors, Ltd. The refinements include an all-in-one phenol formaldehyde plastic

handle, designed and moulded by United Ebonite and Lorival, Ltd., of Little Lever, near Bolton. All-insulated moulded-in switch and cord connector provides absolute electrical insulation. This aspect of the design has completely eliminated burn-outs, which are prevalent on the plug type of iron.

Tea Service for Dolls

From the accompanying photograph one might assume that this tea service was for actual use by children. It is, however, of very much smaller size, the diameter of the cups being about 1½ inches. We found it in the Toys Section at the B.I.F., there exhibited by Lewis Knight, Ltd., of Park Hill Road, Ewell, Surrey. Moulded in urea (white or cream) by Insulators, Ltd., it is subsequently decorated in colour by Lewis Knight, Ltd., under the terms of their licence with Walt Disney Mickey Mouse, Ltd. It will be noticed that the handles of the cups, as also of other pieces comprising the set, are of unconventional "solid" pattern. The Mickey Mouse decorations vary.

The need—a new material with a feminine appeal for women's raincoats, aprons, shoes, curtains . . . The answer—BX P.V.C. sheeting. To countless other needs in modern manufacturing the answer lies in BX Thermo-Plastic Materials.

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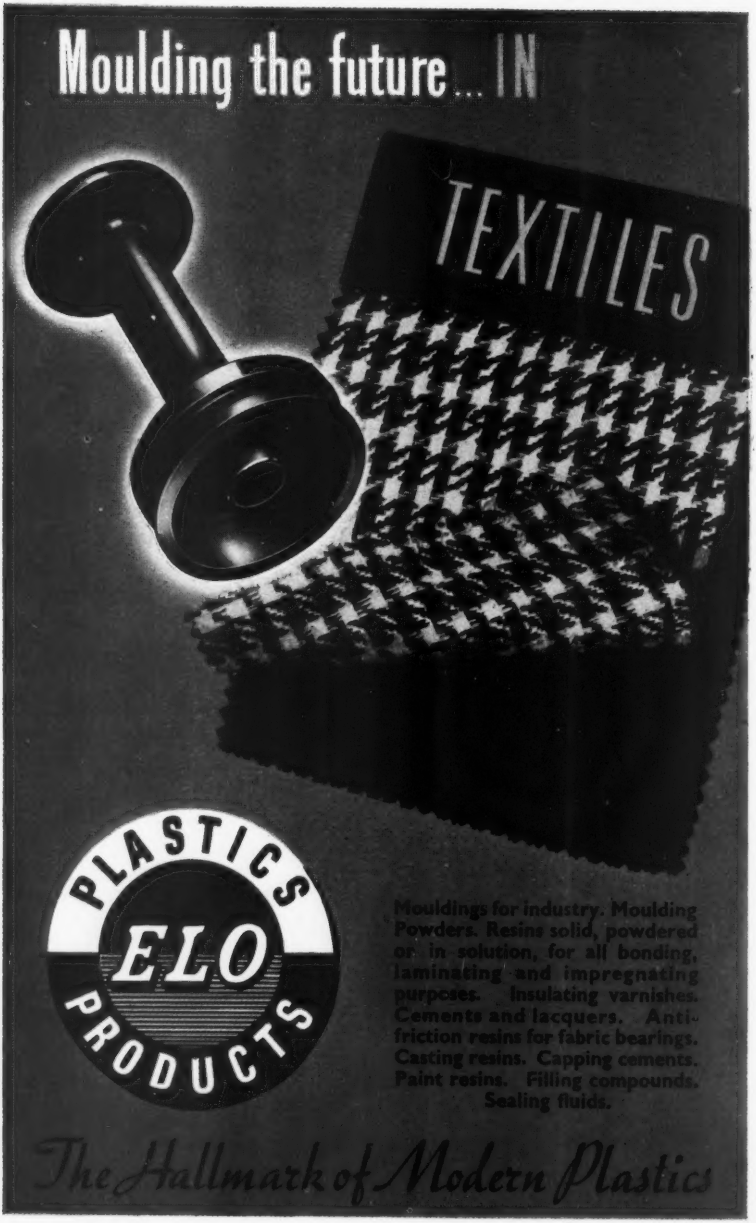
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PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 586,425. Application date: 24.2.45. Accepted: 18.3.47.

Method and Apparatus for Producing Continuous Lengths of Shaped Structures of Synthetic Organic Thermoplastic Materials. M. Spertus.

B.P. 586,447. Application date: 29.6.44. Convention date (U.S.A.): 5.8.43. Accepted: 18.3.47.

Improvements in Self-sustaining Films and Methods for Making Them. B. J. Humphrey and R. J. Reid. To: The Firestone Tire and Rubber Co.

Transparent films, pellicles and sheets suitable for packaging purposes, essentially composed of a vinyl chloride polymer or copolymer plasticized with a copolymer of a conjugated diolefin (butadiene-1, 3) and of an acrylonitrile.

B.P. 586,489. Application date: 25.9.44. Accepted: 20.3.47.

Improvements in and relating to the Purification of Vinyl Esters. H. R. C. Pratt and S. T. Glover. To: Imperial Chemical Industries, Ltd.

B.P. 586,491. Application date: 6.10.44. Accepted: 20.3.47.

Improvements in the Production of Chemically Resistant Pipes and Tubes. G. C. Tyce. To: Imperial Chemical Industries, Ltd.

Chemically resistant pipes and tubes produced by coating sheets of fibrous material with dispersions of polyvinyl chloride or polymethyl methacrylate, winding these sheets around a mandrel, thus forming a pipe and heating the assembly under pressure to gelatinize the dispersion.

B.P. 586,537. Application date: 20.10.44. Convention date (U.S.A.): 19.11.43. Accepted: 21.3.47.

Improvements in the Stabilization of Vinyl Aromatic Compounds. E. R. Erickson. To: The Mathieson Alkali Works.

Stabilization of polymerizable styrene and substituted styrenes by adding an inhibitor (alkoxy-hydroquinone).

B.P. 586,539. Application date: 14.11.44. Convention date (U.S.A.): 3.5.44. Accepted: 21.3.47.

Aromatic Carbonates and Polymers Thereof. To: Wingfoot Corporation.

Preparation of allyl and substituted allyl esters of allyl carbonate derivatives and of their polymers.

B.P. 586,609. Application date: 15.9.44. Accepted: 25.3.47.

Improvements in or relating to Adhesive Polymeric Materials.

Cementing of rubber-like bodies to metal surfaces by interposition of an adhesive film of cyclized polymers of substituted pentadienes (e.g., methylpentadiene). This method is suitable for the lining of tanks with natural rubber, synthetic rubbers, polyisobutylene, etc.

B.P. 586,610. Application date: 6.10.44. Convention date (U.S.A.): 6.10.43. Accepted: 25.3.47.

Coating Compositions. To: E. I. Du Pont de Nemours and Co.

Coatings for metal food containers comprising copolymers of vinyl chloride with ethylene-alpha-beta-dicarboxylic esters (maleic acid or fumaric acid) and a heat-hardening phenolformaldehyde resin.

B.P. 586,626. Application date: 15.12.44. Accepted: 25.3.47.

Improvements relating to the Application of Polymers and Interpolymers of Vinyl Chloride to Surfaces. G. C. Tyce. To: Imperial Chemical Industries, Ltd.

Vinyl chloride/vinyl acetate and vinyl chloride/vinylidene chloride copolymers polymerized in aqueous solution containing a volatile solvent such as cyclo-hexanone or tetra-hydropyrane can be used as a lining material for corrosion resistant tanks or alternatively for the manufacture of laminated fibrous materials.

B.P. 586,715. Application date: 26.7.43. Accepted: 28.3.47.

Improvements in or relating to the Production of Synthetic Resins. J. J. P. Staudinger and C. A. Brighton. To: The Distillers Co., Ltd.

Polymerization process for vinyl halides and/or vinylidene halides in the presence of oxides of styrene, indene and their nuclear-substituted derivatives.

B.P. 586,716. Application date: 6.9.43. Accepted: 28.3.47.

Improved Process for the Production of

Synthetic Rubber-like Materials. To: Standard Oil Development Co.

Continuous emulsion copolymerization of a butadiene hydrocarbon and styrene.

B.P. 586,759. Application date: 13.7.44. Accepted: 31.3.47.

Improvements in or relating to the Surface Coating of Sheet Material Consisting of or Coated With Polyvinyl Chloride. J. H. McGill. To: Imperial Chemical Industries, Ltd.

Sheet materials consisting of or coated with a composition containing gelatinized polyvinyl chloride, the surface of which bears a layer containing an interpolymer of methacrylic acid and a methacrylic ester (methyl methacrylate). Such sheets are much more slippery at ordinary temperatures and much less sticky at raised temperatures than ordinary fabrics.

B.P. 586,767. Application date: 1.9.44. Accepted: 31.3.47.

The Coating of Surfaces with Polythene Compositions. H. M. Glass, G. C. Tyce and L. D. Spurr. To: Imperial Chemical Industries, Ltd.

Process of bonding polythene compositions to metal surfaces by coating the surfaces first with a layer of polyalkylene sulphide, such as Novoplas, Thiokol or Perduren, and using a temperature sufficiently high to obtain adherence between the polyalkylene sulphide and the polythene composition. The polythene composition may be applied by hot spraying.

B.P. 586,768. Application date: 1.9.44. Accepted: 31.3.47.

The Coating of Surfaces with Polythene Compositions. G. C. Tyce. To: Imperial Chemical Industries, Ltd.

Method of bonding polythene compositions to metal surfaces by interposing a layer of asbestos, which can be attached to the metal surface by any known process (acid-resisting cement, phenol formaldehyde cement, etc.). The polythene composition may be sprayed on by a flame gun or applied in sheet form under heat and pressure.

B.P. 586,793. Application date: 5.6.44. Convention date (U.S.A.): 4.10.43. Accepted: 1.4.47.

Improvements in or relating to the Manufacture of Glass Fibre Synthetic Resin Laminates. Communicated by A. P. Thurston.

Glass fibre-resin laminates produced by applying a urea resin to the surface of glass fibres. The cure of this resin is catalyzed by an acid produced by decomposition of certain organic compounds which are applied to the glass fibres prior to the application of the resin. Examples quoted are: ethyl silicate, diethyl sulphate, ethyl-, methyl-, or phenyl-silicon trichloride.

B.P. 586,796. Application date: 9.8.44. Accepted: 1.4.47.

Improvements in or relating to Polymerization. To: Imperial Chemical Industries, Ltd.

Manufacture of polymers by polymerizing or copolymerizing one or more polymerizable compounds in an aqueous dispersion containing an oxygen-yielding catalyst (hydrogen peroxide, benzoyl peroxide or water-soluble salts of perdisulphyric acid) and sodium formaldehyde sylphoxylate. Polymerization occurs rapidly and the products are very uniform.

B.P. 586,801. Application date: 2.10.44. Convention date (U.S.A.): 30.9.43. Accepted: 1.4.47.

Improvements in or relating to the Production of Fluid Compositions Containing Solutions of Synthetic Linear Polyamides. To: Imperial Chemical Industries, Ltd.

Stable solutions of synthetic polyamides suitable for the production of films and shaped articles, produced by dissolving a synthetic linear polyamide in benzaldehyde or an alpha hydroxy nitrile (isobutyraldehyde cyanhydrin, acetaldehyde cyanhydrin or formaldehyde cyanhydrin). Refers particularly to polyhexamethylene adipamide and polyhexamethylene sebacamide.

B.P. 586,821. Application date: 5.12.44. Accepted: 1.4.47.

Improvements in or relating to a Process for Bonding Polythene to Metal Surfaces. S. G. Foord. To: Standard Telephones and Cables, Ltd.

Bonding of polythene to metal (copper or aluminium) by applying a hot polythene solution to the metal and evaporating the solvent at a temperature exceeding the melting point of polythene. This invention is especially suitable for the manufacture of electric condensers. (See also B.P. 583,694.)

B.P. 586,826. Application date: 19.12.44. Convention date (U.S.A.): 12.4.44. Accepted: 1.4.47.

Plasticizer for Ethenoid Polymers. To: The Resinous Products and Chemical Co.

Plasticizing polyvinyl chloride or polyvinyl acetate or their copolymers with a linear polyester of 1, 2-propylene glycol and sebacic acid.

The Microscopic Examination of Plastic Materials

VI.—Mouldings (Fillers)—(f) Fibrous Materials

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

HAVING examined the hemp fibre with a view to assessing its value as a potential filler, the next material to come under our scrutiny is jute. This fibre is of great commercial importance, and as such we are justified in examining it in some detail.

We find that jute is the name given to the fibre which is obtained from various species of *Corchorus*, of which the most important variety is *C. capsularis*, occurring in cultivated form throughout tropical Asia, where it is valued not only as a source of fibre, but also as an edible vegetable. There are other varieties of *Corchorus* capable of producing fibre. such as *C. oblitorius*, *C. fuscus*, and *C. decemangulatus*, although the two latter varieties are responsible for only a small portion of the jute in commerce. There is also a commercial fibre known as "Chinese jute" which is not a type of jute at all, being derived from *Abutilon avicennae*, commonly known as Indian mallow, whereas the true jute is obtained from *Corchorus*.

Jute was first introduced into Europe at or about the year 1795, and has been used ever since, chiefly for spinning purposes. The fibre is obtained from the bast tissues of the plant, its chief source of origin being India and the East Indian islands.

The plant *C. capsularis* is a dicotyledenous annual, reaching a height of from five to ten feet when mature. It is possessed of a cylindrical stem about three-quarters of an inch in diameter and has few, if any, branches at the top. The leaves are a light green in colour and from four to five inches long. They are some 1½ inches broad at the base, but taper towards the distal end to a sharp, slender point possessing a saw-tooth edge.

The extraction of the fibre from the stalks is carried out by a process of simple water "retting" which is accomplished by soaking the stems, after they have been freed from leaves and seed capsules, in a sluggish stream for a few days, after which time the soft tissues have disintegrated. The stems which are thus retted are next subjected to pressing and "scutching" which produces a very clean fibre almost completely free from woody tissue and other extraneous matter.

The fibre thus produced is from four to seven feet in length and usually of a pale straw colour although some of the highest quality material is much lighter, sometimes being silver-grey in colour, and at the same time possessing a high lustre and some considerable tensile strength. This long, fine

Table 1.—Features of Varieties of Indian Jute (after Kerr)

Variety of fibre	General qualities
Ultariya (Northern)	Possesses best qualities regarding length, colour and strength.
Deswal	Valuable for softness, fineness, bright colour and strength.
Desi..	Long, soft fine fibre, but is fussy and of bad colour.
Deora	Strong, coarse, black used mainly for rope.
Maraingani	Soft, strong and long, very good for spinning, colour poor.
Bakrabadi	Excellent colour and softness.
Bhatral	Very coarse but strong, used for rope.
Karumganji ..	Fine, long and very strong, good colour.
Mirganji	Medium quality fibre.
Jangipuri	Short, weak fibre, unsuitable for spinning.

Fig. 191.—Jute fibre (transverse section). Mag. 90 diameters.

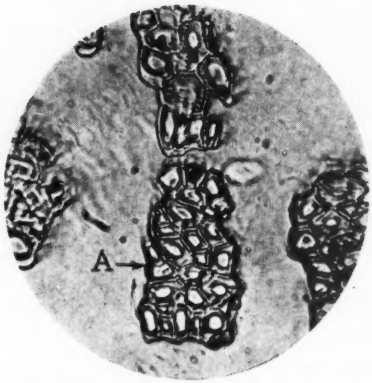

Fig. 192.—Jute fibre (transverse section). Mag. 190 diameters.

fibre is, of course, of great use for spinning and weaving into the familiar forms. There remain, however, the ends of the plants and short lengths of waste fibre; these are technically known as "jute butts" or "jute cuttings." The latter forms are used in the manufacture of certain types of paper and at this stage it might be suggested that this material could conceivably be used as a filler without much modification.

However, as in the case of hemp, there are many varieties of jute, some producing fibres of better quality than others, and in considering the use of this fibre for filling moulding powders, it would appear that a not inconsiderable degree of care be taken over its selection. In Table 1 (after Kerr) the salient features of ten varieties of Indian jute are tabulated in order that we may obtain some idea of the variations in properties to be expected; for example, some are described as being stronger than others, and perhaps finer also, while others are seen to excel with regard to colour and so on. It will be seen from this that these same factors will influence the behaviour of this fibre, when used as a filler, according to what properties are required of the finished moulding, be they strength, colour, fineness of finish, etc., or, as is more probable, a combination of all.

Examining the structural details, so that we may evaluate its utility as a filler, we find the bast or tracheid cells of the jute fibre to vary from 1.5 to some 5 or 6 mm. in length, and usually about 20 or 25 μ across their largest diameter. Thus it will be seen that the average L.B. ratio is in the region of 90. This figure is smaller than that for manila hemp, which has an L.B. ratio of 250 (see June issue), thus indicating a shorter histological element.

In transverse section the jute fibre elements are interesting, inasmuch as they differ considerably from hemp; in the latter, the elements are relatively thin-walled and possess a large lumen, which results in a somewhat irregular outline to the cross-section. In Fig. 191, we see a group of jute fibres at a magnification of 90 diameters. It will be seen that each fibre is composed of a bundle of tracheid elements from phloem tissue; three such fibres are shown at "A." At this magnification we obtain a good general picture of the fibre in transverse section, and it is possible to distinguish the shape of the tracheids which are seen to be more regular than those of manila hemp, so much so in fact, that their outlines may be regarded as being in general polygonal in shape, with each element clearly distinguishable.

A better idea of the structure of this

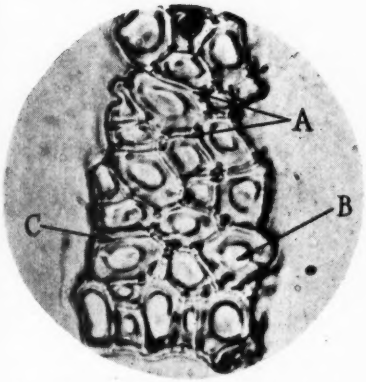

Fig. 193.—Jute fibre (transverse section). Mag. 375 diameters.

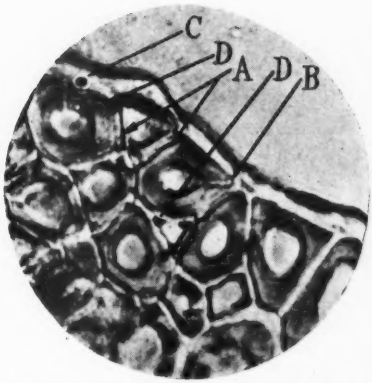

Fig. 194.—Jute fibre (transverse section). Mag. 560 diameters.

material is obtained from Fig. 192, at 190 diameters, from which the regular nature of the structure is clearly ascertained; in the fibre marked "A" the manner in which the elements fit into one another will be noted. In this way a highly compacted structure is obtained producing great strength. The tracheids in general will be seen to possess an open lumen of variable size which is usually accompanied by walls which are fairly thick, but although in a great many cases the thickness of the cell wall is almost equal to the diameter of the lumen, there are a number of instances of elements possessing a large lumen, in consequence of which the wall is much thinner by comparison; however, in so far as the lumen of these elements is concerned, the form in which it appears in the jute fibre element would appear to offer certain advantages when it comes to using the material as a filler, because with the rigid thick wall keeping the lumen open, the element is capable of being more thoroughly impregnated with resin than is the case with those fibre elements whose walls are thin, resulting in the collapse of the lumen. From this point of view it is permissible to assume that jute would function better than hemp.

An interesting feature of this section is the appearance shown at the planes of contact between any two tracheids, which indicates a clear-cut division between the substance of one element and the next. This is the so-called median layer, which at one time was thought to be composed of a different substance to the wall itself, but as this layer gives a reaction with iodine and sulphuric acid, which is very little different from that produced by the deeper substance of the wall itself, there is, of necessity, considerable doubt about this conjecture, and in order that this point may be made clear, let us examine briefly the development of cellulose in plant tissue.

In the beginning it should be borne in mind that cellulose exists in a growing plant in two main forms, the resistant and the non-resistant, or the so-called "alpha" and "beta." The non-resistant or β cellulose is found in the cell walls of the non-fibrous, soft tissues, and as it is a pentose - carbohydrate its empirical formula is the same as that for starch ($C_6H_{10}O_5$) and in fact it is so close to starch in nature that it is often regarded as being this latter in film form, as against the granular nature of starch proper. This is not surprising, when it is realized that the whole process of cellulose development is in reality one of starch transformation, the starch being produced in the first instance by the

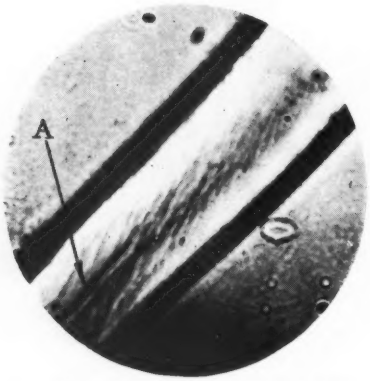

Fig. 195.—Jute fibre element, showing spiral structure. Mag. 550 diameters.

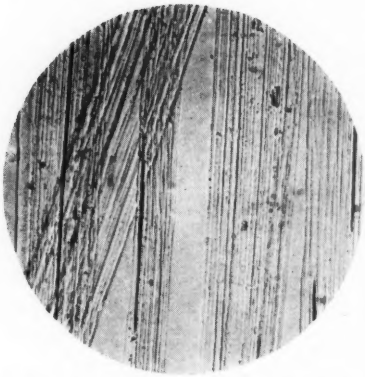

Fig. 196. — Jute fibres, showing lumen. Mag. 90 diameters.

photosynthesis of atmospheric carbon-dioxide, instigated by the chlorophyl under the influence of sunlight, via the intermediate formation of formaldehyde which is immediately polymerized to hexose sugar, in the main, with small amounts of secondary starches also developed. The hexose is then converted to starch by the removal of the elements of one molecule of water.

Starch itself is insoluble in sap and is stored against the time when it will be required for the synthesis of cellulose, which is apparently achieved by first putting the starch into soluble form by the absorption of a molecule of water, thus reconverting to sugar, which in solution in the sap is, of course, in a mobile condition and may be transported to wherever it is required. Having arrived at the scene of action, as it were, it is converted into a less resistant primary (β) cellulose which, nevertheless, is still soluble and capable of conversion to sugar by hot alkaline solutions. While β cellulose is a neutral body, an acid substance known as pectin is also made in the same way, from starch, at the same time and it is from these two substances that the resistant α-cellulose on the one hand and lignin on the other, are developed to form the fibrous cellulosic and ligno-cellulosic tissues of maturity.

From this it will be seen that the development of cellulose and lignin is a gradual process taking place by stages and could almost be regarded as the polymerization of sugar along two main lines, the one leading to α-cellulose and the other to mature lignin, it is therefore not surprising that these two substances are to be found in various stages of development.

As the lignin is developed simultaneously with the cellulose and in the same location, it is apparent that these two substances will exist in circumstances where the one inter-penetrates or infiltrates the other, but this condition might be regarded as one where the lignin infiltrates the cellulose, due to the development of the former being slower than that of the latter. This will be seen to result in a situation where there exists mature cellulose infiltrated with immature and yet plastic lignin which solidifies rapidly towards the end of the development of the cell.

As the lignin infiltrates the cellulose, it is clear that it is continuous from cell to cell, thus at maturity it acts as a binding agent cementing the cells firmly together. It would seem that between the walls of adjacent cells there exists a very thin layer of pure lignin, which will be visible in optical section, due to the

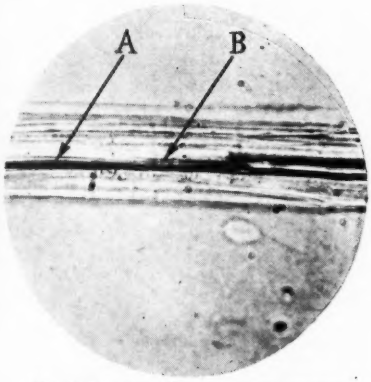

Fig. 197. Jute fibre, showing uneven lumen. Mag. 190 diameters.

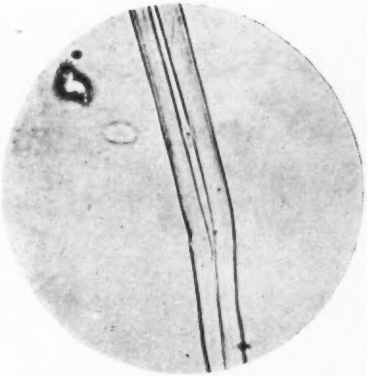

Fig. 198. Jute fibre element showing uneven bore. Mag. 290 diameters.

difference in refractive indices between lignin and cellulose. It is the solution of this layer of lignin (if such it be) by alkalis which allows the separation of the fibre elements in the mascerating treatment.

If a section of the fibre is examined at higher magnification, it is possible to demonstrate the presence of the median layer with greater clarity. Thus we see in Fig. 193 a jute fibre magnified 375 diameters, which clearly shows the existence of this layer as a fine black line at the planes of junction between the sides of the cells. The angular nature and thick walls of the cells will also be noted (two good examples are shown at "A"), the rigid wall is in sharp contradiction to the cell walls found in hemp, cotton, or flax, and whereas a large proportion of the rigidity is due to the actual thickness of cellulose, it should be remembered that the jute fibre is also more highly lignified, resulting in a chemical composition which is quite different from those fibres which are not lignified, and being, as it is, composed of the lignin-cellulose complex (ligno cellulose) much of the rigidity is due to its chemical composition, and as such its behaviour towards various reagents is different from that of cellulose, the chief difference being in the production of a yellow coloration by iodine and sulphuric acid, against the blue given by cellulose in similar circumstances.

Apart from the existence of the median layer, this illustration exhibits evidence of other structural characteristics, which although far from clear are nevertheless worthy of closer investigation. For example, at B is shown what appears to be a break in the cell wall, while at C we see indications of the possible existence of stratification of the wall, which, if it exists, is indicative of growth and no growth periods, coupled possibly with a spiral orientation of the miscelle structure.

In view of this, let us examine this fibre at a greater magnification such as that shown in Fig. 194, which is a photomicrograph of a portion of a jute fibre at 560 diameters. In this illustration the median layer is again seen very clearly at several points, such as those marked A. The point of chief interest in this photograph, however, is the structure indicated at B. and C. which would appear to indicate with reasonable certainty the existence of a discontinuity in the cellulose wall, which bears a strong resemblance to the pit channels encountered in the structure of the coconut shell tracheid. If these are such, then we have a degree of confirmation regarding the observations on similar pits seen in the hemp elements (see "Plastics," June,

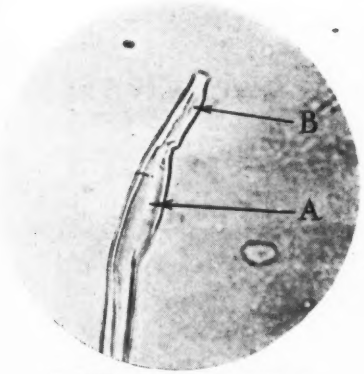

Fig. 199.—Jute fibre element tip. Mag. 290 diameters.

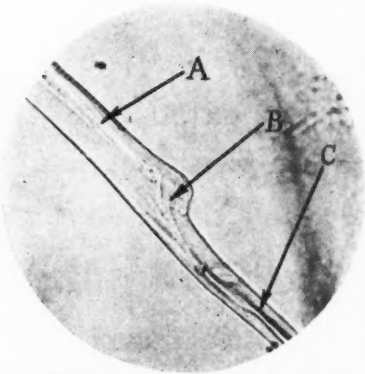

Fig. 200.—Jute fibre element tip, showing deformity. Mag. 290 diameters.

1947), for in the present case they are demonstrated in transverse section.

In view of the nature of the process of lignification and the similarity of structure to that of the coconut shell, inasmuch that we have in the jute a heavy wall, it is highly probable that these are indeed pit channels which serve a similarly useful purpose, although, as we shall subsequently see, they do not appear to be demonstrable in longitudinal views of the fibre elements. Their existence is, of course, an eminently desirable characteristic from the point of view of facilitating the complete impregnation of the filler particle; however, they do not appear to be continuous with similar channels in adjacent elements and therefore there is no continuous intercommunicating network of channels as in the coconut shell. This fact, coupled with the scarcity of such channels, places their nature and function in the realm of pure conjecture, and in the absence of more definite information regarding their true nature, they must unfortunately so remain.

At the points marked D there is definite evidence of the stratified nature of the cellulose wall of this fibre; in all probability this is an indication of the periodicity in the growth of the wall, which is demonstrable in greater or lesser degree in nearly all natural cellulosic fibres. This also appears to be coupled with the development of a spiral miscelle structure, as pointed out in our study of hemp fibres.

This structure is very marked in the case of the jute fibre, as can be seen from Fig. 195, showing the top surface of a jute fibre element at a magnification of 550 diameters, and from which the miscelle spiral can quite easily be seen to be a great deal more prominent than in the hemp fibre. The lumen of this element (A) is seen to be quite narrow when compared with hemp.

The general appearance of jute is well shown in Fig. 196, where we see some whole fibres at a magnification of 90 diameters. In the preparation of these fibres a small residuum of air is left in the material in order that the lumen may be more distinctly displayed, and these are clearly visible wherever they occur. They will be seen to be narrow and in general cannot be said to be very even; as a matter of fact the lumen of the jute fibre element is noted for its irregularity of diameter along its length and those shown in this illustration will be seen to be so narrow in parts as to become almost obliterated. This is perhaps more clearly shown in Fig. 197, showing a fibre at 190 diameters, where the bore will be seen to be reduced to approximately half its diameter at B when compared with that at

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A, and as we shall subsequently see this may at times be reduced further still.

In examining these jute fibres it will be noticed that there is a complete absence of transverse markings such as those encountered in the hemp fibres. This is interesting from the point of view of its being a useful aid to identification, as the cross-markings would appear to be characteristic of hemp fibres, so much so that one could almost regard them as a means of classification. Thus, for example, we saw that these characteristics appeared in Manila hemp which is obtained from *Musa textilis*, and also in Indian hemp which comes from *Cannabis*. The significance of this lies in the fact that *M. textilis*, is a monocot plant of the family *Musacae*, while *Cannabis* is a dicot belonging to the nettle family or *Urticacae* (see Table 2, "Plastics," May, 1947). The nettle family is, of course, very large, comprising a considerable number of individual species and these markings may be looked upon as being characteristic of the *Urticacae*. It is not surprising, therefore, that when a structure of almost identical type was seen to exist in a family of monocot plants, it was classed under the generic title of hemp.

Returning to our discussion of the uneven bore in the jute fibre element, the manner in which, at times, it is reduced to almost vestigial proportions, is very well shown in Fig. 198, at 290 diameters, where the bore will be seen to have been reduced to a mere line and at this point the fibre might very well be considered to be solid. The reason for the occurrence of this phenomenon is not exactly clear, but it seems probable that it might be due to mechanical forces such as lateral pressure, developed during the growth of the fibre; on the other hand, it could quite conceivably arise as a result of unequal rates of development of the cellulose, at all events, and whatever the cause, it is extremely probable that this characteristic is not due to one cause alone, but a multiplicity of factors of whose interaction this is the net result.

This variation in the diameter of the lumen is subject to wide fluctuations. For example, at the tips of the fibre elements the bore frequently becomes much distorted, due chiefly to distortion of the actual tip shape. This is seen to advantage in Fig. 199, showing one such tip at 290 diameters, where the lumen will quite clearly be seen to have undergone a considerable increase in size at the point A, being diminished again at B, this being the result of the tip of the element becoming distorted owing to opposing growth of the tips of other elements fitting into the general structure of the composite whole, which makes speculation on the nature and magnitude of the mechanical forces in growing tissue, such as this, somewhat interesting.

As can be imagined the effects of this interference result in the production of curious shapes and modification of the tip morphology. Whereas the shapes capable of being produced are legion, that shown in Fig. 199 and one other in Fig. 200 will suffice to illustrate the point. This latter shows a curious deformity, resulting in the production of a bulbous cavity in the lumen at the point marked B, which has developed from the abnormal growth of the element due to the presence of the tip of another unit fitting into the step at B, the differences in size of the lumen will be noted by reference to the points A and C, the latter showing the construction brought about for the same basic reason.

All these variations in the bore diameters of the jute fibre element will tend to make matters somewhat difficult when it comes to considering its utility as a filler, for in this fibre we have a material composed virtually of tubes with rigid walls, which on the face of it would seem to be almost ideal, but in point of fact there exist several factors which are obstacles to the realization of this condition.

(To be continued.)

At the annual general meeting of the British Standards Institution held June 27, Lord McGowan was elected president in succession to Lord Woolton.

PLASTICS IN GERMANY

(continued from page 372)

of any other synthetic resin cold-setting adhesive. Such glues, however, are not considered desirable for gluing at temperatures above 60 degrees C., because of the toxicity of the fumes. The use of ethyl acetate as solvent is advantageous from the viewpoint of not swelling the wood, but there is some disadvantage in health and fire hazards. For the chemistry of the "Polystar" glues see CIOS Report XXVII-39.

FIAT Final Report No. 170.—Experiments on the animalization and waterproofing of cellulose fibres has been under investigation by the I.G. at Dormagen, where the Bemberg cuprammonium process was used for the preparation of rayon and staple fibre. The use of Persistol ground, an emulsion of ceresin wax, and Persistol salt, zirconium oxychloride, gave water repellent fibres, but also caused brittleness. This treatment did not merely form a film on the surface of the fibres, but actually penetrated them; however, it did not confer crease resistance. Melamine was tried as a resin which might give crease resistance, but was discarded because of the brittleness which developed.

FIAT Final Report, No. 712.—At Leverkusen, the I.G. has produced four types of isocyamates under the name Desmodur. The newest product, Desmodur R, is the tri-isocyanate from 2.4-diamino toluene, which was sold as a 20 per cent. solution in methylene chloride. Details of manufacturing procedure are accompanied by flow sheets.

Index to Advertisers

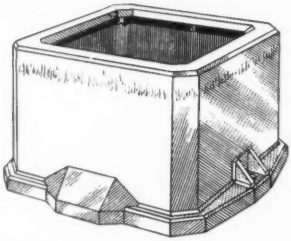
	Page
Albright & Wilson, Ltd.	xliii
Almex, Ltd.	xliv
Bakelite, Ltd.	xxviii
Barber & Duffy, Ltd.	xlvi
B.B. Chemical Co., Ltd., The	xiv
Birkby's, Ltd.	xxxiv
Bridges, F. W., & Son, Ltd.	xlv
British Celanese, Ltd.	xxxvi
British European Airways	xxvii
British Industrial Plastics, Ltd.	xxxvii
British Institute of Plastics Technology	xliv
British Moulded Plastics, Ltd.	xxxi
British Resin Products, Ltd.	i
Bushing Co., Ltd., The	xxvi
Butcher, Henry, & Co.	xlii
BX Plastics, Ltd.	xxxiii
Byson Appliance Co., Ltd.	I
Catalin, Ltd.	Inside Back Cover
Chamberlain & Willows	xl
Cohen, George, Sons & Co., Ltd.	iv
Coldwell, W. B., & Sons, Ltd.	xlii
Cole, R. H., & Co., Ltd.	Back Cover
Courtaulds, Ltd.	xlvi
Crystalate, Ltd.	xii
Davis & Timmins, Ltd.	xl
Desoutter Bros., Ltd.	xxv
Dohm, Ltd.	xli
Duratube & Wire, Ltd.	xxiv
English Steel Corporation, Ltd.	xiii
Erinoid, Ltd.	Inside Front Cover
Evans, Frederick W., Ltd.	xlii
Ferguson, James, & Sons, Ltd.	xvii
Fisher & Ludlow, Ltd.	xl
Gardner, Wm., & Sons (Gloucester), Ltd.	xxxii
Gee, William, Ltd.	xx
General Electric Co., Ltd., The	xxi
G.R.L. Plastics, Ltd.	xxxviii
Herbert, Alfred, Ltd.	vii
Holoplast, Ltd.	xxiii
Imperial Chemical Industries, Ltd.	Front Cover
Jessop, William, & Sons, Ltd.	x
Jones, Samuel, & Co., Ltd.	xxiv
Kent Mouldings	xxii
Kenure, J. F., Ltd.	xliv
Kodak, Ltd.	x
Law, F. W., & Sons, Ltd.	xliv
Light, H. A., Ltd.	xlii
Martin, J.. & Sons, Ltd.	xlvi
M.C.L. and Repetition, Ltd.	xliv
Merchant, Peter, Ltd.	xviii
Micanite & Insulators Co., Ltd., The	xxxv
Ministry of Fuel and Power	vi
Ministry of Labour	ii
Ministry of Supply	xii
Monsanto Chemicals, Ltd.	xxix
Moulded Products, Ltd.	v
National Savings	xlv
New Insulation Co., Ltd., The	xix
New London Manufacturing Co., Ltd.	xxxviii
Page, W., & Sons	xl
Peace, Harold E., & Co., Ltd.	xl
Potts Engineers, Ltd.	xvi
Proved & Producing Properties, Ltd.	xlii
Rediffusion, Ltd.	ix
Reed Bros. (Engineering), Ltd.	xliii
Richard & Hopkins, Ltd.	xxxix
Rootes Mouldings, Ltd.	xli
Rubber Improvement, Ltd.	xxx
Rubber Trading Co. (Kent), Ltd. The	xxxviii
Sellotape	xxii
Shannon, Ltd., The	xiv
Steele & Cowlishaw, Ltd.	xlii
Sternol, Ltd.	xxvi
Stuart Davis, Ltd.	xxxix
Sunvic Controls, Ltd.	xvi
Synchronome Co., Ltd., The	xlvi
Tenaplas, Ltd.	xv
Toolmakers & Designs (Coventry), Ltd.	xxxviii
Turner Mfg. Co., Ltd.	iii
United Ebonite & Lorival, Ltd.	xi
United Plastic & Chemicals (London), Ltd.	viii
Universal Tools, Ltd.	xx
Utilex, Ltd.	xxxix
Vinyl Products, Ltd.	xlvi

Leaves from a Moulder's Notebook

This is the eighth in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. B.I.P. will send a copy of previous notes on request and will welcome comments and enquiries.

Moulding Abrasion

A mould for a deep article of medium or large size, which has a flat face of considerable area (such as a meter cover or a clock case), may suffer attack to



the inside bottom face of the die from the abrasive action of the moulding material as it travels over its surface under pressure. This attack takes the form of minute scratches on the highly polished metal, radiating from the centre of the bottom face of the die to its outer edges. Normally these blemishes would not appear until five to ten thousand mouldings had been made; chromium plating will, however, provide a hard surface skin which will greatly resist such attacks by abrasion. More serious is the similar deterioration of moulds that occurs in cases where the flowing material leaves the horizontal to enter the vertical at a sharp angle, or on an arc with only a small radius such as may be made by a slightly rounded corner. With features of this type in a mould, the impact of the material against the bottom of the vertical wall of the die is often sufficient to wear a groove in a short time; the illustrations show examples of mould abrasion after only a few months in operation.

Here also chromium plating is of some assistance, but the only true remedy is one of design: the vertical and horizontal walls of the moulding should preferably meet on an arc of as large a radius as possible, so that change of direction of moulding material follows an easy curve.

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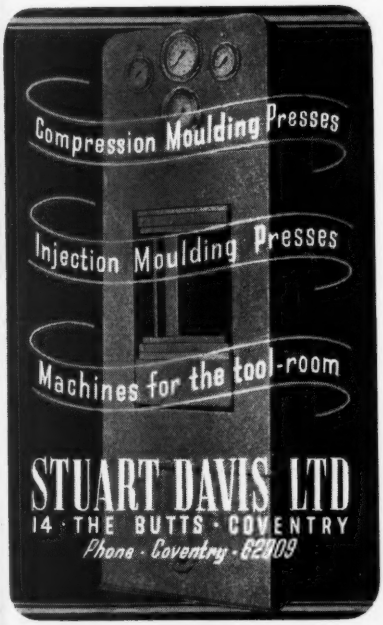
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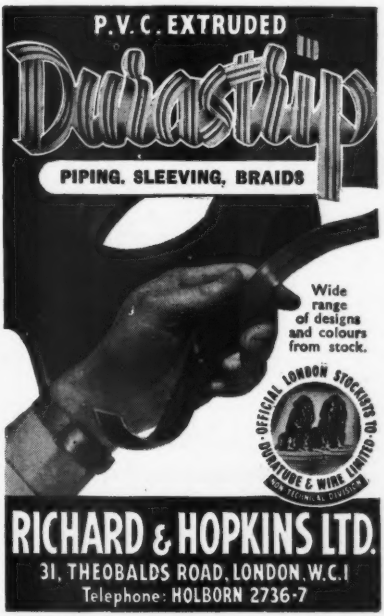
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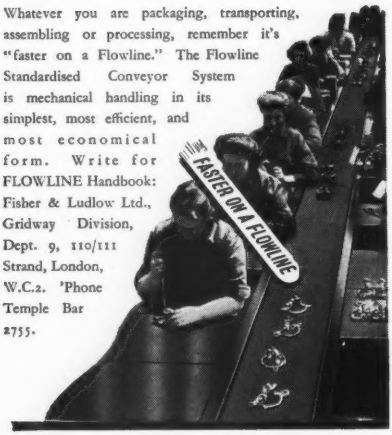

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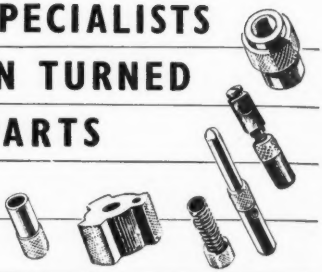

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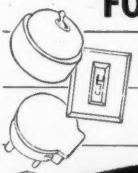

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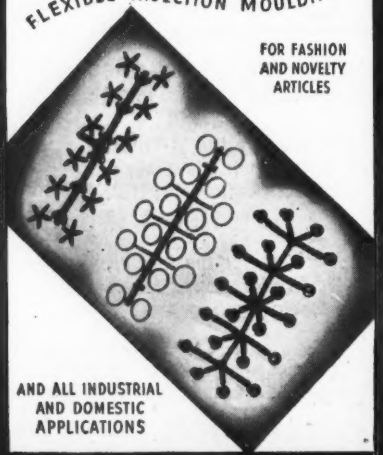

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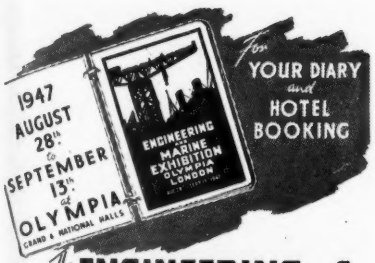

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Perspex. We are stockists of I.C.I. Perspex. Try us for your requirements of clear and coloured sheets. Cuprex, Ltd., 1-3 Robert Street, Strand, W.C.2. Temple Bar 0902. zzz-405

Production Capacity Available and Wanted (contd.)

S. R. F. FREED, LTD.,

THE STOCKISTS OF SHEETS, RODS, TUBES, OFFCUTS AND SCRAP,

OFFER OTHER LINES WHICH CAN BE USED IN COMBINATION WITH PLASTICS,

ULTILIZING ANIMAL AND VEGETABLE PRODUCTS.

Such as tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes, vegetable ivory nuts, porcupine quills, goose and duck feathers, and barrels, etc.

S. R. F. FREED, LTD.,
27b HIGH STREET, SOUTH NORWOOD, S.E.25.
Phones, Livingstone 4042; Sanderstead 2056.
122-402

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 129-9541

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-410

W. Page and Sons,
34 Langside Crescent, Southgate, N.14. Phone, Palmers Green 5087.
The following lines always in stock:—
Wooden boxes, 18 by 12 by 9, at 2s. 8d. each, 21 by 12 by 9 at 2s. each. With lids.
12 by 12 by 12 Australian butter boxes at 1s. 4d. each.
Large tea chests at 5s. 9d. each. Small tea chests at 4s. 6d. each.
Export cases in ½-in. timber all round, 30 by 17 by 14, at 12s. 6d. each.
Cartons. Large, medium assorted cartons sold mixed in approximately the following sizes:—20 by 12 by 12, 19 by 13 by 15, 21 by 14 by 13, 23 by 13 by 10½, 13 by 10 by 21, etc., etc.
5,000 lots and over at 1s. 3d. each. Under 5,000 at 1s. 4d. each. 30,000 in stock.
Small mixed cartons. Sizes range from 17 by 12 by 6 to 8 by 5 by 5, approximately. To-day's cheapest carton at 6d. each.
Thousands of others in stock. We would welcome your inquiries, which shall receive our prompt and courteous attention.
All goods free delivered in the London area, f.o.r. elsewhere. zzz-421

Wanted, plastic articles of every description for export and British Isles. Representatives active in all parts. Can place large orders for export. Write N. Gerver, Plastic Dept., 2-10 Mare Street, Hackney, London, E.8. 131-394

Wanted, plastic sheeting in all thicknesses from 1-16-in. to 1-in. Can place large orders for home and export markets. Please submit samples and prices to N. Gerver, 2-10 Mare Street, Hackney, London, E.8. 125-393

Work wanted, tool room available for all sorts of press tools. Press work, assembling, spraying and all sorts of engineering to your design. Universal Components, Ltd., 19 Sunderland Terrace, W.2. Bay 6776. 131-392

The Superb Stamping Co. Stamping in genuine gold "Krome" and colours for volume production. Acetates, phenolics, wood, leather products where trade marks, wording and ornamentation required. 84 Highbury Park, London, N.5. Canonbury 1915. 122-x2323

Cellulose acetate scrap urgently required; best prices paid. Write, Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. Phone, Metro. 9641-5. zzz-424

We are able to undertake certain short or long runs of highly specialized medical and technical plastic moulded products. Injection, compression or sheet fabrication. Use our services for the preparation of prototypes. All inquiries strictly confidential. Box 7678, care of "Plastics." zzz-422

We have immediate capacity for design of all types plastic moulds and can assist in placing them for manufacture. Write or phone, The Lion Design Service Co., Ltd., 4 Castelnau, Barnes, S.W.13. Riverside 7771. 122-658

Mouldings. The I.D. Co. method of cast resin mouldings for small or large runs. Initial cost is much lower than for Bakelite mouldings. Have your product moulded by this new technique. Mouldings from 1 to 160 ozs. Inquiries to Industrial Development Corporation, 4 Whitchurch Road, Pangbourne, Berks. Phone, Pangbourne 39. 123-660

We have increased capacity for the manufacture of plastic moulds, and can offer a high standard of workmanship and good delivery.
Blundell Bros. (Luton), Ltd. Engineering Division, Chaul End Lane, Luton, Beds. Luton 3976 and 4294. 123-657

Production Capacity Available and Wanted (contd.)

Well-established firm would welcome orders, both home and abroad, for new model, lady's compact in coloured Perspex and brushed gold. Box 8141, care of "Plastics." 123-x3076

Specialists in polythene mouldings have capacity up to 8 oz. Tools designed and manufactured if required. Inquiries welcomed. Box 9236, care of "Plastics." 122-x6642

Capacity available for finishing all types of plastic mouldings; trimming, drilling, polishing, assembly, etc. Box 8059, care of "Plastics." 122-401

Perspex. Large stocks, all thicknesses, available, particularly 1-16-in. and ¼-in., coloured. Write for price and stock list. Almex, Ltd., Exchange Buildings, Stephenson Place, Birmingham, 2. 122-399

Capacity available for plastic injection moulding of small articles 10 grammes or under. Powder in stock. Also light metal stampings. Taylor Page, Ltd., 55 Gordon Square, W.C.1. Phone, Mus 8784. 122-7

Well-established Plastic Consulting Engineers with extensive offices and practice in the Midlands area, requires offers of further practice or agencies. Box 9041, care of "Plastics." 122-19

Plastic Specialist requires large or small contract in Perspex, cellulose acetate sheets or tubes, P.V.C. sheets or wired tube. We have specialized knowledge in work of the following natures: Office equipment, Perspex fancy goods, plastic cartons, control knobs, acetate tube bending, acetate and P.V.C sheet manipulation, plastic covering of metal parts. Box 9042, care of "Plastics." 122-18

Grinding, sorting, disintegrating, demetalizing of your scrap carried out to your requirements and specification. Please send inquiries to Box 9033, care of "Plastics." 122-21

Perspex. We are stockists of I.C.I. Perspex. Try us for your requirements of clear and coloured sheets. Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-405

Beautiful plastic bracelets, made with nickel-plated loops interwoven with plastic in attractive colours; selling at 5s. and upwards. £1 per dozen, post free. Sample, 2s. 6d. Reynolds, 16 Wensley Street, Blackburn, Lancs. zzz-434

R.F. Welded Plastic Goods supplied at competitive prices. Also welding capacity available. Box 9018, care of "Plastics." 122-x6028

Capacity available for short runs of small specialized medical and technical mouldings; also high-class sheet fabricated articles of all kinds. Box 8677, care of "Plastics." 122-x4750

Grinding capacity available for cellulose acetate scrap only. Stewart Plastics, Ltd., 87 Gloucester Road, Croydon. Phone, Tho 3739. 122-36

Injection moulding capacity available on 3-oz. injection moulding machine for short and long runs. Box 9035, care of "Plastics." zzz-438

Cockerham, Spencer and Nesbit, Ltd., Manor Buildings, Crawsham Hill, Pudsey, Nr. Leeds. Makers of dies for injection moulding. Your inquiries invited. Box 8680, care of "Plastics." 124-x4653

Part-time design or detail work required on small injection moulds. Box 8744, care of "Plastics." 122-x4893

Capacity for design-manufacture of press tools, moulds, jig, fixtures repetition turning, springs and presswork. The Super Ease Tool Co., Highfield Works, Oakley Road, Redditch. 122-5

Injection moulding capacity. Up to 4oz. available. Expert advice on all problems. Box 9071, care of "Plastics." 122-4

Heat sealing capacity available for P.V.C. Modo Products, Beaumont Chambers, Beaumont Crescent, W.14. 122-x6504

Pressing capacity available for P.V.C., cellulose acetate and all types of plastic materials, sheet or moulded, preferably with customers' own moulds. Long runs undertaken. Prompt deliveries. Inquiries to Box 9185, care of "Plastics." 122-x6320

Moulding capacity offered on 15-50-ton compression presses if tools available. Please forward particulars to Box 9208, care of "Plastics." 122-39

Compression moulding capacity available, also black powder for small article (½ to 1 oz.) off customers' own mould. Box 9203, care of "Plastics." 122-43

SITUATIONS VACANT

Shorthand Typists, Private Secretaries, Clerks, etc., If you are in urgent need of staff, contact Embassy Secretarial Employment Bureau, Excel House, Whitcomb Street, W.C.2. Whitehall 5924. We specialize in efficient personnel. 124-8069

Assistant sales manager (administrative) required by manufacturers of well-known Palitoy dolls, toys and Durite flexible clothing. Commencing salary £750-£800. Excellent prospects. Application in writing to Sales Manager, Cascelloid, Ltd., Leicester. 122-22

Situations Vacant (contd.)

CITY OF LEICESTER EDUCATION COMMITTEE.

COLLEGE OF ART.
(Principal: Kenneth Holmes, A.R.C.A.)

Applications are invited for the post of full-time specialist in Commercial Art Design, Lettering and Display, for September, 1947. It would be an additional advantage if candidates were interested in the development of Design for Plastics.

Salary in accordance with the Burnham Scale.

Applications, together with two recent testimonials, should be sent to the Registrar, Leicester College of Art, The Newarke, Leicester, not later than two weeks after the appearance of this advertisement.

ELFED THOMAS,
Director of Education.
Newarke Street,
Leicester. June 9th, 1947.
122-26

Firm in the Plastics Industry (Southern Counties) have the following vacancies in their Research Laboratory:—
Qualified Chemist for work on organic problems.
Qualified Physical Chemist.
Qualified Physicist for research in industrial applied physics.
Well-paid positions with good prospects for the right men. Applicants are invited to submit in strict confidence full personal particulars, including experience and salary expected. Box 8496, care of "Plastics."
122-661

Chemists.—Large organization requires key chemical personnel to take charge of new project involving the manufacture of specialized plastic materials.

Applicants must be graduate chemists with several years' experience in chemical manufacture.

Age 25 to 35.

Mechanical and personnel handling abilities essential

Successful applicants will be given extensive training including six months in America.

Apply by letter, giving full details of education, industrial experience, and salary required, with a recent photograph, to Box 9067, care of "Plastics."
122-33

Technologist required for the development of a new plastic process, B.Sc. standard preferred but not essential. Applicants must be prepared to work on development of entirely new process which offers excellent future possibilities; a certain amount of travelling may be involved later. Opportunity to develop initiative and resource. Salary in accordance with experience and qualifications. Apply, Box 443, care of Granthams, Advertising Agents, Reading. 122-6

Practical chemist required with full knowledge of synthetic adhesives manufacture. State age, experience and salary required. Box 9036, care of "Plastics." 122-13

Required for six-eight-week visit to India, skilled service engineer to install automatic injection moulding machines and 300-ton Bakelite press. Good remuneration and return air passage paid. Apply, with full details of experience, to Box 9029, care of "Plastics."
122-17

Experienced injection moulder required with knowledge ophthalmic and associated trades. Reply, stating age, experience, salary, to Stephen Harland, Solicitor, 16 Coney Street, York. 122-25

Toolmakers required for moulding tool work, experience essential. First-class craftsmen need only apply; top rate of pay to the right men; five-day week. Send full details to Seaforth, Watchett Works, Oakhurst Road, Southend. 124-693

Foreman required to take charge of small expanding plant processing thermo-plastic raw materials; experience of grinding, mixing, drying, pigmenting and thermo-plastic sheet manipulation an advantage. Good prospects, permanent position. Write, giving details of experience and salary required, to Box 9034, care of "Plastics." 124-694

Working toolroom foreman required by small firm in Essex. Experience in production of moulding tool work essential; five-day week. It is essential that applicant has sound organizing experience and ability and is a keen disciplinarian. Well-paid position for the right man. Send fullest details of past experience to Box 9026, care of "Plastics." 124-700

Representatives required for South London area and Midlands area. Knowledge of laminated plastics and their applications is essential. Salary, expenses and commission. Full particulars to Box 9202, care of "Plastics." 122-44

SITUATIONS WANTED

Moulding shop foreman seeks similar position, 19 years' practical experience on compression and injection, first-class references. Home or abroad. Box 9019, care of "Plastics." 124-x6024

General Manager, competent engineer, thoroughly experienced with all types plant in plastics and general engineering industries, 20 years' practical experience machinery design, construction and installation. Free at short notice. Write, Box 9207, care of "Plastics."
122-41

Designer and maker of prototype samples of the highest class for showcase and exhibition work, seeks position with good established firm. Samples for easily mass-produced work a speciality. Write, Box 9206, care of "Plastics." 122-40

Executive (36) with comprehensive experience of moulding, fabricating, manipulating, blowing and post-forming of plastics and laminated materials, also development of low-pressure laminates, printing, engraving and packaging, seeks progressive opening with concern where responsibility and loyalty are appreciated. Box 9201, care of "Plastics." 122-x6338

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 125-8459

VALUATIONS

PROCEDURE IN RESPECT INCOME TAX CONCESSIONS—DEFERRED REPAIRS.
MARTIN WOOD, SON AND PARTNERS,
The Valuers, of 81 High Holborn, W.C.1.
Phone, Hol 4485
SCHEDULES OF BUILDINGS—MANUFACTURING PROPERTY, PLANT REGISTERS, DETAILED INVENTORIES COVERING INSURANCE AND TAX CLAIMS. WE SPECIALIZE PRECISION MACHINERY.
122-391

WANTED

Scrap plastic material wanted, any quantity. Perspex, Lactoid, Catalin, Acetate, Bakelite, Presspahn. Write, Plastics Dept., J. E. Hoare, Byton Chambers, Amen Corner, Tooting, S.W.17. 124-404

Scrap. Why not let a well-established firm quote you for celluiose acetate, polystyrene, P.V.C. cuttings and other thermo-plastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-395

Wanted, urea, scarab, phenol powders; any quantities, large or small; top prices paid. Box 7421, care of "Plastics." 122-x557

Celluloid sheets or offcuts in 20-60/000 in. thick, in transparent or opaque, urgently required for manufacturing purposes. Box 6899, care of "Plastics."
122-9545

Regular Supplies of Polythene Powder or offcuts required, plain or segregated colours. Must be free from contamination. Samples and price to Box 8495, care of "Plastics." 122-662

Pink and White Acetate or Nitro sheeting. Thickness .020-.040. Full sheets or offcuts. Top prices paid for clean material. Apply, Studio Manufacturing Co., 169-171 Brearley Street, Birmingham. Phone, Aston 3550. 122-x4132

Wanted, translucent bowls, dishes, trays, in Perspex or similar, brilliant self-colour of the highest quality. Box 8832, care of "Plastics." 122-x5276

Will buy for cash, quantities of .045-in. thick acetate sheets in opaque and transparent colours. Box 8927, care of "Plastics." 122-x5704

Celluloid. Veined white celluloid, .125 mm. thick, polished one side only, large quantities immediately for export. Samples and lowest quotations. Box 9040, care of "Plastics." 123-695

Will buy for cash, quantities of injection moulding powder in opaque and transparent colours. Box 8926, care of "Plastics." 122-x5704

Manufacturers require to purchase or hire moulds suitable for use on 4-oz. injection moulding machines. Box 8791, care of "Plastics." 122-x8791

MISCELLANEOUS

Perspex and Tufnol for sale, various colours, sizes and thicknesses, including clear in stock at original I.C.I. prices. Box 9032, care of "Plastics." 122-14

P.V.C. scrap for sale in varied form, chips, hides, tubing, etc. Write, Box 9044, care of "Plastics."
123-699

Miscellaneous (contd.)

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 122-9353

Extend Your Trade.
Use a Trade Mark. Consult
Trade Mark Protection Society,
12 Church Street, Liverpool. 130-9745

Perspex powders for disposal, regular supplies clean ground perspex in various mesh sizes. Box 8522, care of "Plastics." 122-676

JOHN F. MANN, LTD.,
DIRECT IMPORTERS OF MOULDING POWDERS.
Offer
UREA FORMALDEHYDE.
PHENOL FORMALDEHYDE.
POLYSTYRENE, etc., etc.
Prompt and forward delivery.
143 CANNON STREET, LONDON, E.C.4.
Phone, Mansion House 1270.
123-692

Huts. Nissen type, 36 ft. by 16 ft. and other sizes; also other industrial buildings suitable for workshops, canteens, site offices, clubs, etc. No licence required. Write, phone or call (open Saturday afternoons). J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305 zzz-430

For sale, cellulose acetate sheets—clear. 3 mm., 2 ft. 6 ins. by 1 ft. 6 ins., 30 cwt.; 4 mm., 18 ins. by 18 ins., 5 cwt.; 5 mm., 18 ins. by 18 ins., 20 cwt. Box 8523, care of "Plastics." 122-675

For sale, 15 tons P.V.C. black compound (recovered); samples available. Write to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-428

CUPREX, LTD.,
Stockists of I.C.I. Perspex,
Offer specially:
1/16-in., ⅛-in. and ¼-in. coloured.
Write for stock list and particulars to:—
FINSBURY PAVEMENT HOUSE,
120 MOORGATE,
LONDON, E.C.2.
122-38

We are now able to supply an adhesive suitable for cementing the Perspex which we supply. Inquiries to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-429

For sale, P.V.C. strippings from cables, red, blue, brown, yellow and black, large quantities available. Box 8493, care of "Plastics." zzz-425

For sale, P.V.C. sheeting, 36 ins. wide, .015 to .018 thick, in black and other colours, at 6s. 0½d. per pound; delivery ex stock. Plastic Materials, Ltd., 3 Red Place, London, W.1. 123-x3420

For sale, P.V.C. scrap. Offers invited. Box 8494, care of "Plastics." zzz-426

Range of plastic moulds for producing bakelite door furniture for sale singly or as one lot. Box 9025, care of "Plastics." 122-9

Highly polished and embossed 40-thou. P.V.C. plastic material for sale in various attractive colours. Apply for details to Box 9038, care of "Plastics." 122-11

For immediate disposal. Substantial stocks of Crinothene, Celastoid, Utilex, cellulose acetate pol/pol, asbestos sheeting, etc. Write or phone, Aplastics and Co., Ltd., Burlington Works, Burlington Road, Fulham, London, S.W.6. Renown 1800. 122-x5899

Ground Perspex. Any mesh supplied for facing leather cloth, display purposes, etc. Write Box 9043 care of "Plastics." 123-698

Perspex for Sale, new sheets, offcuts, large and small scrap, powders; clear and colours. Box 9024, care of "Plastics." 124-696

Calendered P.V.C. Sheeting—Wholesaler has large surplus stock first quality opaque green, peacock blue, royal blue, maroon, yellow, orange and white, sheeting widths 30 ins. and 36 ins., and offers substantial price reduction to clear. Box 9068, care of "Plastics." 122-32

For Sale. Tufnol sheets 4 ft. by 2 ft. by ½. Lambert and Corkran, Ltd., 'Lytecraft' Works, Hailsham, Sussex. 122-24

Miscellaneous (contd.)

Approximtely 2,500 Sheets Cellulose Acetate, first-class condition, 41 ins. by 21¼ ins. by .005 ins. and .007 ins. thick, for immediate delivery. Offers to Box 9030, care of "Plastics." 122-16

Advertisers have for sale pastel shaded translucent Urea powder for export only, dutiable, but duty re-covered on proof of export. Box 8488, care of "Plastics." 122-29

Quantity of New Perspex Sheets, clear, cream, green, black in ⅛ and 3/16 thickness. Inquiry Box 9022, care of "Plastics." 123-697

Blister hangers, 91 ft. span and 45 ft. long, and other sizes. Steel or asbestos roofing. Suitable for repair shops, factories, storage, etc. Details from J. Thorn and Sons, Ltd., Box 115a, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-437

Perspex brand acrylic sheet, stockists offer good range in clear and coloured, stock lists available. J. H. Berry (Plastics), Portland Works, Annesley Woodhouse, Notts. 122-1

Polystyrene. Clear, virgin material. 2½ tons for export goods. Ex stock. Free delivery London area. Box 9069, care of "Plastics." 122-2

Manufacturer has stock highest quality hair combs for export, various sizes. Keenest prices. Immediate delivery. Box 9070, care of "Plastics." 122-3

For immediate disposal, 500 sheets of pink Thermo-Plastic, .030-in. thick. Size of sheets, 36 ins. by 28¼ ins., weight approximately 1½ lb., 15s. per sheet. Samples will be submitted upon request. Box 8906, care of "Plastics." 123-5561

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. zzz-436

Cellulose acetate tubes (black and white), various dimensions, and rods, ⅜-in., pink, green; and 3 mm. white for sale. Box 9088, care of "Plastics." 122-35

Plastic boards, 1/16 in., specially treated, highest artistic finish, suitable for panelling, furniture, bath, splash-backs, etc.; plain colours or marble effect, and wood (oak, mahogany, walnut, etc.), sheets 8 by 4 or cut to requirements. Prompt deliveries, Larks Spraying Process, Monument Hill, Weybridge. 122-45

For sale constantly, cut-offs of ⅛ and 1/16-in. natural Holoplast, from 1s. per lb., according to size of pieces. Larks Spraying Process, Monument Hill, Weybridge. 122-46

100 lb. of assorted Lactoid rod for sale in various colours, 5s. per lb. Box 9204, care of "Plastics." 122-42

Regular supplies of imported plastics available: Polystyrene, cellulose acetate, luminiscent cellulose acetate, ethyl cellulose, phenolic, moulding compounds, phenolic resins and adhesives, extruded polystyrene rods, celluloid in sheets, rods and tubes, cellulose acetate in sheets, casein sheets and rods, P.V.C. extrusion compound. Please send inquiries to Box 9205, care of "Plastics." zzz-439

We supply within 24 hours Golderstat Photocopies, the inexpensive reproduction of documents, illustrations, photographs, etc. Golderstat, 54 Golders Gardens, London, N.W.11. Spe 5643. 126-659

P.V.C. sheets, 54 ins. by 24 ins., 50 thou. thick, embossed and plain surfaces, all colours in stock, 6s. 6d. per lb. Felbo and Co., Ltd., 119 Regent Street, London, W.1. Regent 6639. 122-37

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JULY, 1947. Vol. XI. No. 122. Plastics TWO SHILLINGS

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by

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